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CORRECTIVE MEASURES STUDY REPORT ADDENDUM AREA OF CONCERN 617 (AOC 617) ZONE F CNC CHARLESTON SC
8/1/2003
CH2M HILL

CORRECTIVE MEASURES STUDY REPORT ADDENDUM

AOC 617, Zone F

Charleston Naval Complex
North Charleston, South Carolina

SUBMITTED TO
U.S. Navy Southern Division
Naval Facilities Engineering Command

CH2M-Jones

August 2003

Contract N62467-99-C-0960

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CH2MHILL

August 20, 2003

Mr. David Scaturo
Division of Hazardous and Infectious Wastes
South Carolina Department of Health and
Environmental Control
Bureau of Land and Waste Management
2600 Bull Street
Columbia, SC 29201

Re: Corrective Measures Study Report Addendum (Revision 0) – AOC 617, Zone F

Dear Mr. Scaturo:

Enclosed please find two copies of the Corrective Measures Study Report Addendum (Revision 0) for AOC 617 in Zone F of the Charleston Naval Complex (CNC). This report has been prepared pursuant to agreements by the CNC BRAC Cleanup Team for completing the RCRA Corrective Action process.

Please do not hesitate to contact me at 352/335-5877, extension 2280, if you have any questions or comments.

Sincerely,

CH2M HILL

Dean Williamson, P.E.

cc: Tim Frederick/Gannett Fleming, Inc. w/att
Rob Harrell/Navy, w/att
Gary Foster/CH2M HILL, w/att

CORRECTIVE MEASURES STUDY REPORT ADDENDUM

Area of Concern 617, Zone F

Charleston Naval Complex
North Charleston, South Carolina

SUBMITTED TO
U.S. Navy Southern Division
Naval Facilities Engineering Command

PREPARED BY
CH2M-Jones

August 2003

Revision 0
Contract N62467-99-C-0960
158814.ZF.EX.03

Certification Page for Corrective Measures Study Report Addendum (Revision 0) — AOC 617, Zone F

I, Dean Williamson, certify that this report has been prepared under my direct supervision. The data and information are, to the best of my knowledge, accurate and correct, and the report has been prepared in accordance with current standards of practice for engineering.

South Carolina

P.E. No. 21428

Dean Williamson, P.E.

8/13/2007

Date

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Acronyms and Abbreviations

AOC	area of concern
BRAC	Base Realignment and Closure Act
CA	corrective action
CMS	corrective measures study
CNC	Charleston Naval Complex
COC	chemical of concern
COPC	chemical of potential concern
DAF	dilution attenuation factor
EnSafe	EnSafe Inc.
EPA	U.S. Environmental Protection Agency
ft bls	feet below land surface
GWRTAC	Groundwater Remediation Technologies Analysis Center
HI	hazard index
ILCR	Incremental Lifetime Cancer Risk
$\mu g/L$	microgram per liter
LUC	land use control
LUCMP	land use control management plan
MCL	maximum contaminant level
MCS	media cleanup standard
NAVBASE	Naval Base
NFA	no further action
ORP	oxidation-reduction potential
PCB	polychlorinated biphenyl
PRB	permeable reactive barrier
PRG	preliminary remediation goal
RAO	remedial action objective

Acronyms and Abbreviations, Continued

RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RGO	remedial goal option
SCDHEC	South Carolina Department of Health and Environmental Control
SSL	soil screening level
SVOC	semivolatile organic compound
VOC	volatile organic compound
UST	underground storage tank

Section 1.0

1.0 Introduction

In 1993, Naval Base (NAVBASE) Charleston was added to the list of bases scheduled for closure as part of the Defense Base Realignment and Closure Act (BRAC), which regulates closure and transition of property to the community. The Charleston Naval Complex (CNC) was formed as a result of the dis-establishment of the Charleston Naval Shipyard and NAVBASE on April 1, 1996.

Corrective Action (CA) activities are being conducted under the Resource Conservation and Recovery Act (RCRA), with the South Carolina Department of Health and Environmental Control (SCDHEC) as the lead agency for CA activities at the CNC. All RCRA CA activities are performed in accordance with the Final Permit (Permit No. SC0 170 022 560). In April 2000, CH2M-Jones was awarded a contract to provide environmental investigation and remediation services at the CNC.

A RCRA Facility Investigation (RFI) Report Addendum and Corrective Measures Study (CMS) Work Plan were prepared for Area of Concern (AOC) 617 in Zone F of the CNC (CH2M-Jones, 2001). The RFI Report Addendum and CMS Work Plan presented the remedial action objectives (RAOs) and media cleanup standards (MCSs) proposed for AOC 617, and the document was approved by the U.S. Environmental Protection Agency (EPA) Region IV on behalf of SCDHEC in December 2001. This same report recommended no further action (NFA) for AOC 616, which is located approximately 50 feet north of AOC 617; the NFA recommendation was also approved by EPA Region IV and SCDHEC.

A CMS Report was prepared by CH2M-Jones for AOC 617 and submitted to EPA in February 2002 (CH2M-Jones, 2002). The CMS focused on zinc-impacted groundwater that was identified beneath a former galvanizing plant located at AOC 617. The corrective measure recommended in the CMS was groundwater extraction, treatment, and disposal to the sanitary sewer. EPA approved the CMS in May 2002.

The original CMS report recommended that a pump test be completed to assess aquifer conditions and provide design information needed for the groundwater recovery system. A work plan for the pump test was developed and approved by EPA on October 22, 2002. The pump test activities, including installation of new wells, were performed in October and November 2002. The results of the pump test are presented in Appendix C to this CMS report addendum.

Due to the extremely low yield of the aquifer, the constant rate pump test had to be prematurely terminated. A groundwater extraction rate of only 500 milliliter per minute (ml/min) could not be sustained.

The results of the pump test have significant implications for the viability of the recommended corrective measure (pump and treat). Based on the results of the pump test and the inability of the aquifer to yield adequate quantities of groundwater, the pump and treat remedy recommended in the original CMS report cannot be effectively implemented. Accordingly, this CMS report addendum re-evaluates the two remaining proposed alternate remedies (long-term monitoring/natural attenuation and in situ stabilization/ precipitation) and provides a recommendation for an alternate remedy that will be protective of human health and the environment.

1.1 Corrective Measures Study Report Addendum Purpose and Scope

This CMS report addendum evaluates corrective measure alternatives for zinc-contaminated groundwater at AOC 617 and provides recommendations that supercede the original CMS report recommendation, based on the additional hydrogeologic information collected as part of the pump test. Zinc in groundwater was the only chemical of concern (COC) identified for AOC 617 in the RFI Report Addendum. Figure 1-1 illustrates the location of AOC 617 within Zone F. The insert on Figure 1-1 shows the location of Zone F within the CNC. Figure 1-2 is an aerial photograph showing the layout of AOC 617.

This CMS report addendum consists of: 1) the identification of alternate corrective measure alternatives that are considered to be technically appropriate for addressing zinc-contaminated groundwater; 2) an evaluation of the alternatives using standard criteria from EPA RCRA guidance; and 3) a recommendation for a corrective measure alternative for the site.

1.2 Background Information

This section of the CMS report addendum presents background information on the facility, site history, and a summary of the nature and extent of the COCs at the site. This information was previously presented in the original CMS and is essential to the understanding of the remedial goal options (RGOs), MCSs, and ultimately the evaluation of corrective measure alternatives for AOC 617. Additional information on the site and hydrogeology in the Zone F area of the CNC is provided in the *Zone F RFI Report, Revision 0* (EnSafe Inc. [EnSafe], 1999).

1.2.1 Facility Description

As shown in Figures 1-1 and 1-2 of this report, AOC 617 is currently paved. AOC 617 is located in an industrial area east of Hobson Avenue. The CNC Reuse Plan identifies this area for industrial land use. The City of North Charleston zoning for this site is M-2, for marine industrial use.

1.2.2 Site History

AOC 617 is the site of a former galvanizing plant, designated Building 1176, which operated from the early 1940s to approximately 1985. Shortly thereafter, Building 1176 was demolished to facilitate the expansion of Building 69, which is a shipping and supply warehouse located immediately south of AOC 617. As stated earlier, the site is currently paved and is used as an access area for shipping operations. Historical drawings also indicate that this area was paved during Building 1176 operation.

Information regarding specific details of historical galvanizing operations conducted at the site is limited. Available records indicate the former presence of a single 3,000-gallon underground storage tank (UST) used for chemical storage. Historical records also indicate the presence of a series of large (approximately 15 ft by 20 ft) rectangular tanks within the building, which were used for acid, caustic, chemical storage, and process use. These tanks were apparently removed in conjunction with the demolition of the building. There is no record of a release(s) from any of these tanks.

1.2.3 COC Summary

Over three sampling events during the RFI, EnSafe and CH2M-Jones sampled surface (0 to 1 ft below land surface [ft bls]) and subsurface (3 to 5 ft bls) soil at the seven locations shown in Figure 1-3. Soil samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, pesticides/polychlorinated biphenyls (PCBs), and cyanide. Detailed information on the analytical results and the screening of those results for the determination of COCs can be found in the *Zone F RFI Report, Revision 0* (EnSafe, 1997), and the *RFI Report Addendum and CMS Work Plan for AOC 616/617, Zone F, Revision 0* (CH2M Jones 2001). No surface or subsurface soil COCs were identified for AOC 617.

Although the subsurface soil zinc concentration at F617SB003 was greater than the background range of concentrations for Zones F and G, the zinc concentration was less than the EPA soil screening level (SSL) (at a dilution attenuation factor [DAF]=10), which indicates that the subsurface soil in this area is not a source for the zinc in groundwater and does not require remedial action.

Four groundwater wells were installed at AOC 617 over a period of 5 years. The locations of these wells are shown in Figure 1-4. Groundwater samples were analyzed for metals, PCBs, and SVOCs. Results of groundwater analyses were compared to the screening criteria, and the chemicals of potential concern (COPCs) that were identified included aluminum, arsenic, cadmium, cobalt, manganese, nickel, thallium, and zinc. The concentrations of these metals were reviewed and compared to appropriate screening criteria in the RFI Report Addendum. Based on this analysis of the COPC concentrations, the only groundwater COC identified at AOC 617 was zinc. Zinc exceeded the applicable criteria during more recent sampling only in monitoring well F617GW003.

Potentiometric contours of groundwater under AOC 617 as measured in October 2002 during the recent aquifer testing are shown in Appendix A of this CMS report addendum. They illustrate the generally north to northeasterly gradients in the shallow groundwater. The zinc plume in groundwater is relatively limited in size. Figure 1-5 shows an estimated area of zinc exceeding the proposed MCS (discussed in Section 2.0 of this report) of 11,000 micrograms per liter ($\mu g/L$), based on the most recent groundwater data.

1.2.4 Summary of Conclusions and Recommendations from the *RFI Report Addendum and CMS Work Plan* (CH2M-Jones, 2001)

The RFI Report Addendum for AOC 617 concluded the following:

- No surface or subsurface soil COCs were identified.
- Zinc in groundwater within the vicinity of monitoring well F617GW003 was identified as the only groundwater COC.

As a result, the RFI Report Addendum recommended that a focused CMS be undertaken to address zinc in groundwater at AOC 617, within the vicinity of monitoring well F617GW003.

1.3 Summary of Approach for Selecting Candidate Corrective Measure Alternatives for AOC 617 In Original CMS

A variety of corrective measure approaches are conceptually feasible for addressing zinc in groundwater at AOC 617. A Technology Evaluation Report for metals-contaminated soil and groundwater, developed by the Groundwater Remediation Technologies Analysis Center (GWRTAC), that describes many potentially feasible technologies was presented in Appendix B of the original CMS report. The potentially feasible technologies included:

- Natural attenuation;
- In situ treatment via stabilization/precipitation or electrokinetic processes;
- Pump and treat methods, using various aboveground treatment methods; or
- Permeable reactive barriers (PRBs).

Based on the overall site conditions, CH2M-Jones identified the following candidate corrective measure alternatives as the most feasible for the site:

- Natural Attenuation with Land Use Controls (LUCs);
- In situ stabilization/precipitation; or
- Pump and treat using relevant extraction and discharge technologies.

The above three corrective measures were evaluated in the original CMS and pump and treat was selected as most appropriate, based on the assumed aquifer characteristics. Given the low yield nature of the aquifer that was revealed during the pump test, pump and treat will not be effective. The remaining two alternatives above are re-evaluated in this CMS report addendum to select an alternate remedy.

1.4 Report Organization

This CMS report addendum consists of the following sections, including this introductory section:

1.0 Introduction — Presents the purpose of and background information relating to this CMS report addendum.

2.0 Remedial Goal Objectives and Evaluation Criteria — Defines the RGOs for AOC 617, in addition to the criteria used in evaluating the corrective measure alternatives for the site.

3.0 Description of Candidate Corrective Measure Alternatives — Describes each of the candidate corrective measure alternatives for addressing zinc in groundwater.

4.0 Evaluation and Comparison of Corrective Measure Alternatives — Evaluates each alternative relative to standard criteria, then compares the alternatives and the degree to which they meet or achieve the evaluation criteria.

5.0 Recommended Corrective Measure Alternative — Describes the preferred corrective measure alternative to achieve the MCS and RGOs for zinc in groundwater based on a comparison of the alternatives.

6.0 References — Lists the references used in this document.

Appendix A contains groundwater elevation contours from October 2002.

Appendix B contains cost estimates developed for the proposed corrective measure alternatives.

Appendix C contains the methodology and results of the pump test results, including well logs and construction details for the newly installed wells.

All tables and figures appear at the end of their respective sections.

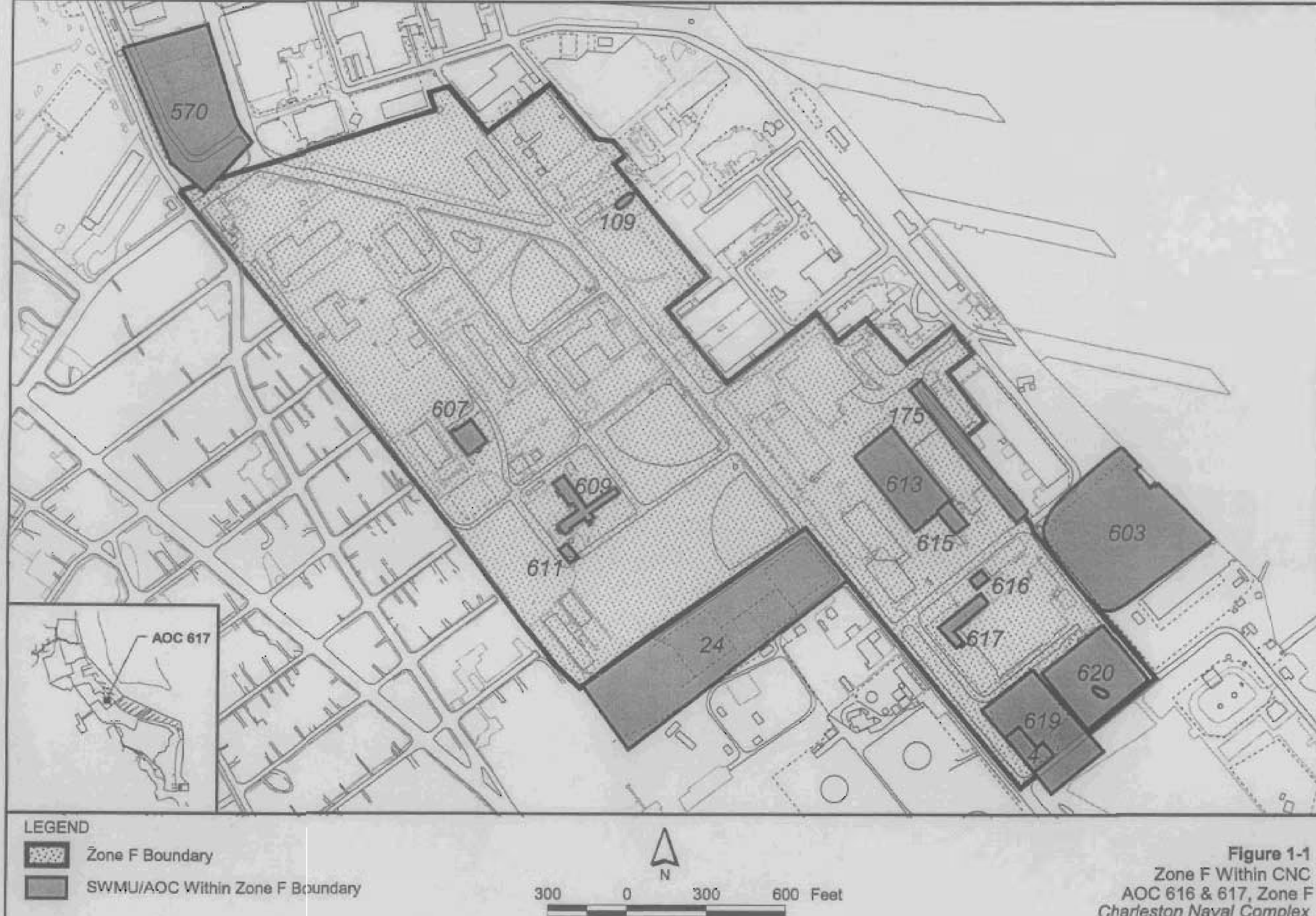


Figure 1-1
Zone F Within CNC
AOC 616 & 617, Zone F
Charleston Naval Complex

File Path: C:\11\gis\CNC\cnc_aoc617_znf.apr, Date: 31 Oct 2001, User: GHALL

CH2M Hill

LEGEND
69A Existing Structure
AOC 616 & 617 Boundary

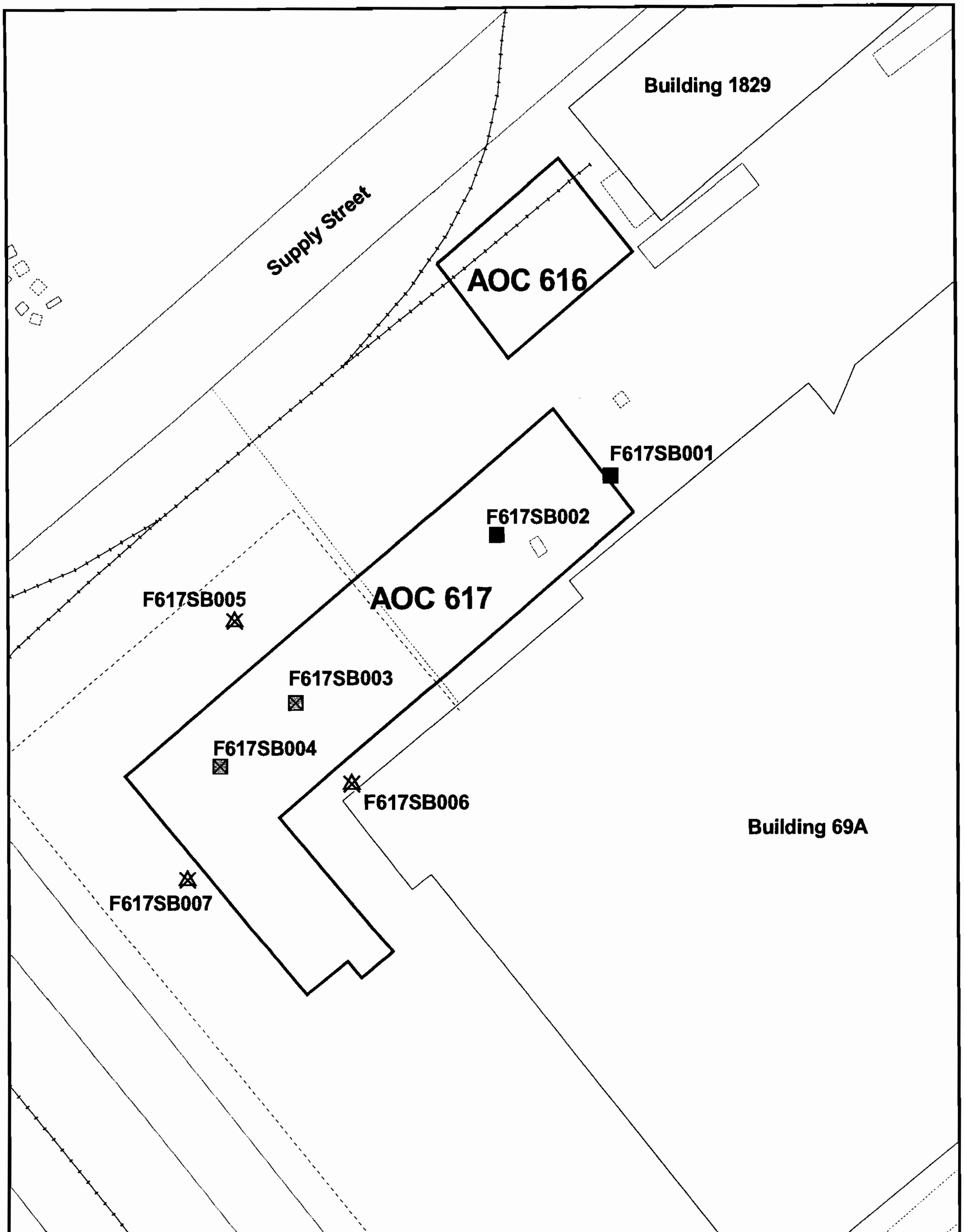
Note: Aerial Photograph Taken in 1997

N
100 0 100 Feet

Figure 1-2
Site Layout
AOC 616 & 617, Zone F
Charleston Naval Complex

CH2M Hill

File Path: C:\18gis\CNC\cnc_aoc617_znf.apr, Date: 31 Oct 2001, User: GHALL



Soil Sample Locations Installed by CH2M - Jones
Originally Reported Soil Sample Locations
Originally Reported Soil Sample Locations Resampled by EnSafe
Fence
Railroads
Roads
AOC Boundary
Buildings
Pavement

N

0 40 80 Feet

Figure 1-3
RFI Addendum Soil Sample Locations
AOC 617, Zone F
Charleston Naval Complex

CH2MHILL

File Path: C:\18gis\Projects\Zone_F\aoc_617\aprs\aoc_617.apr, Date: 25 Feb 2002 14:45, User: AHOLECEK, Figure 1-3 - Figure 1-3 RFI Addendum Soil Sample Locations

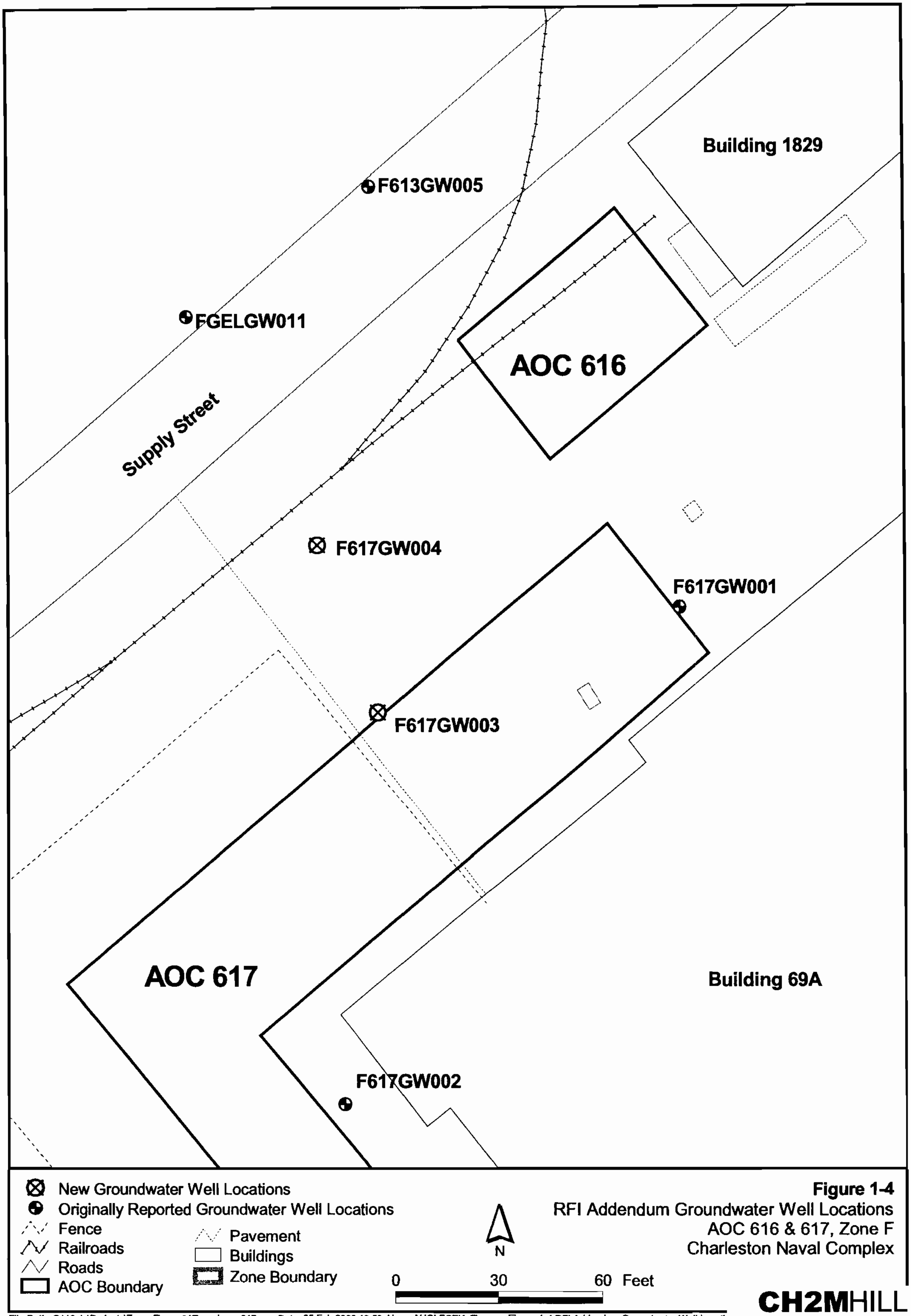


Figure 1-4
RFI Addendum Groundwater Well Locations
AOC 616 & 617, Zone F
Charleston Naval Complex

File Path: C:\18gis\Projects\Zone F\aoc 617\aprs\aoc 617.apr, Date: 25 Feb 2002 13:59, User: AHOLECEK, Figure - Figure 1-4 RFI Addendum Groundwater Well Locations

NOTE: Original figure color

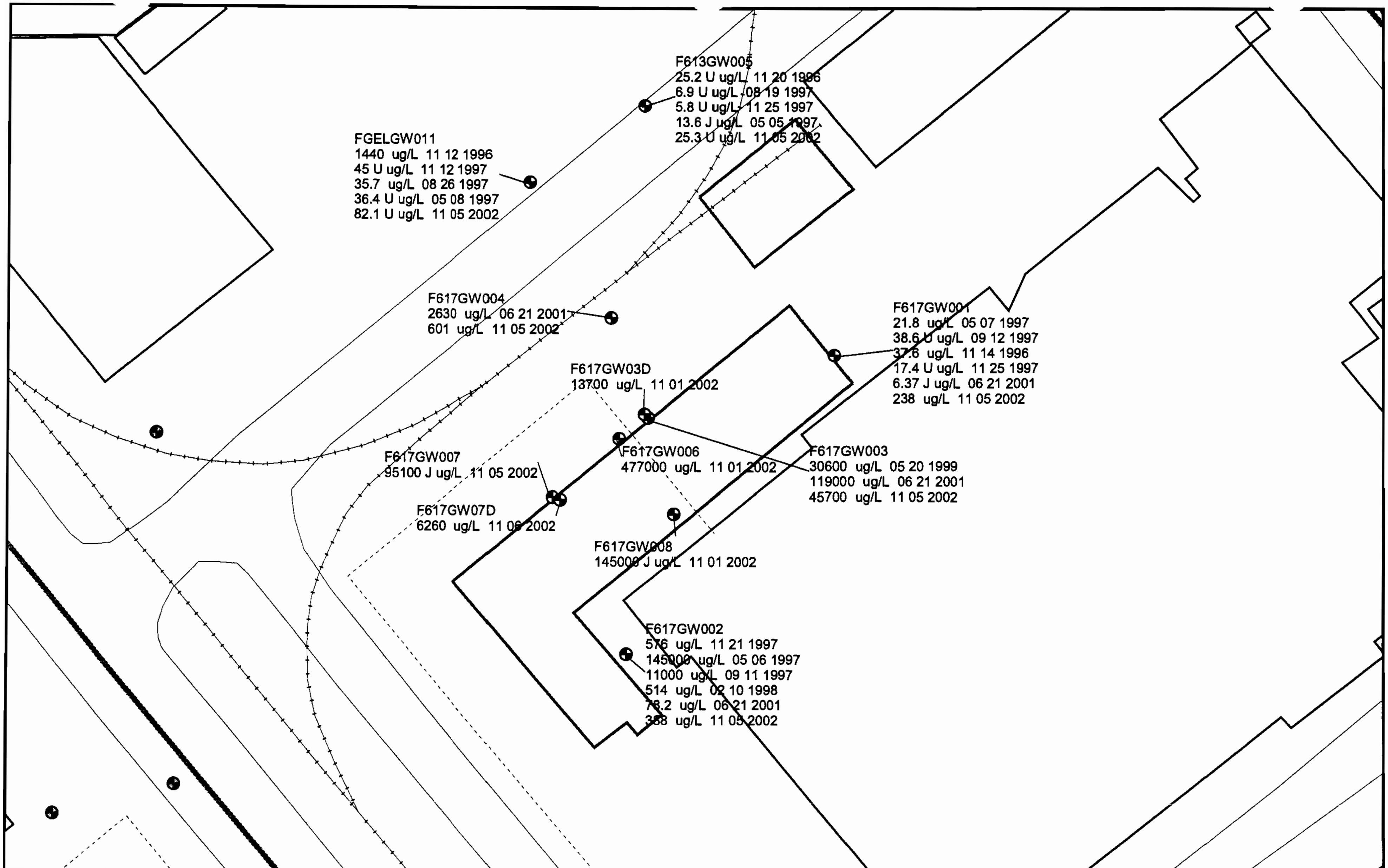


Figure 1-5
Zinc Concentrations in Groundwater
AOC 617
Charleston Naval Complex

File Path: c:\18gis\cnc\cnc-egis.apr, Date: 13 Aug 2003 10:04, User: DWILLIAM, EGIS: Charleston Naval Complex - Figure 1-5 Zinc Concentrations in Groundwater

2.0 Remedial Goal Objectives and Evaluation Criteria

Under RCRA, RGOs and MCSs are typically developed at the end of the risk assessment in the RFI. RGOs can be based on a variety of criteria, such as drinking water maximum contaminant levels (MCLs), specific incremental lifetime cancer risk (ILCR) target levels (e.g., 1E-04, 1E-05, or 1E-06), target Hazard Index (HI) levels (e.g., 0.1, 1.0, 3.0), or site background concentrations. For a particular RGO, specific MCSs can be determined as target concentration values that the selected alternative is required to achieve. Achieving these goals should protect human health and the environment, while achieving compliance with applicable state and federal standards.

2.1 Remedial Action Objectives

RAOs are medium-specific goals that protect human health and the environment by preventing or reducing exposures under current and future land use conditions. The RAOs identified for the groundwater at AOC 617 are 1) to prevent ingestion and direct/dermal contact with groundwater having unacceptable non-carcinogenic risk; 2) to prevent migration to offsite areas; and 3) to restore the aquifer to beneficial use. Because no COCs were identified in soils, no RAOs were developed for surface or subsurface soil at AOC 617.

2.2 Media Cleanup Standards

RGOs and MCSs for AOC 617 were presented in the *RFI Report Addendum and CMS Work Plan* (CH2M-Jones, 2001). The focus of this CMS is to evaluate alternatives that will remediate zinc in groundwater at AOC 617. The concentration of zinc in groundwater at the site ranged from 6.37 to 119,000 $\mu g/L$ during the groundwater sampling through the CMS preparation. Zinc concentrations measured in groundwater during the aquifer testing in October 2002 ranged from less than the method detection limit in downgradient wells to 477,000 $\mu g/L$ within the plume. Since there is no MCL for zinc in groundwater, the MCS/RGO selected is the RBC (11,000 $\mu g/L$, based on a HI=1.0). This value is also the EPA Region IX preliminary remediation goal (PRG) for zinc. The greatest zinc concentrations in groundwater have occurred in monitoring wells F617GW003 and F617GW006.

The corrective measure alternatives to be evaluated include monitored natural attenuation and in situ stabilization/precipitation.

2.3 Evaluation Criteria

According to the EPA RCRA CA guidance, corrective measure alternatives should be evaluated using the following five criteria:

1. Protection of human health and the environment;
2. Attainment of MCSs;
3. The control of the source of releases to minimize future releases that may pose a threat to human health and the environment;
4. Compliance with applicable standards for the management of wastes generated by remedial activities; and
5. Other factors, including (a) long-term reliability and effectiveness; (b) reduction in toxicity, mobility, or volume of wastes; (c) short-term effectiveness; (d) implementability; and (e) cost.

Each of these criteria is defined in more detail below:

1. **Protection of human health and the environment.** The alternatives will be evaluated on the basis of their ability to protect human health and the environment. The ability of an alternative to achieve this criterion may or may not be independent of its ability to achieve the other criteria. For example, an alternative may be protective of human health, but may not be able to attain the MCSs if the MCSs were not developed based on human health protection factors.

2. **Attainment of MCSs.** The alternatives will be evaluated on the basis of their ability to achieve the MCS defined in this CMS. Another aspect of this criterion is the time frame required to achieve the MCS. Estimates of the time frame for the alternatives to achieve RGOs will be provided.

3. **The control the source of releases.** This criterion deals with the control of releases of contamination from the source (the area in which the contamination originated) and the prevention of future migration to uncontaminated areas.

4. **Compliance with applicable standards for management of wastes.** This criterion deals with the management of wastes derived from implementing the alternatives (i.e., treatment or disposal of zinc-contaminated residuals from groundwater treatment

processes). Corrective measure alternatives will be designed to comply with all standards for management of wastes. Consequently, this criterion will not be explicitly included in the detailed evaluation presented in the CMS, but such compliance would be incorporated into the cost estimates for which this criterion is relevant.

5. **Other factors.** Five other factors are to be considered if an alternative is found to meet the four criteria described above. These other factors are as follows:

   a. Long-term reliability and effectiveness
   Corrective measure alternatives will be evaluated on the basis of their reliability, and the potential impact should the alternative fail. In other words, a qualitative assessment will be made as to the chance of the alternative's failing and the consequences of that failure.

   b. Reduction in the toxicity, mobility, or volume of wastes
   Alternatives with technologies that reduce the toxicity, mobility, or volume of the contamination will be generally favored over those that do not. Consequently, a qualitative assessment of this factor will be performed for each alternative.

   c. Short-term effectiveness
   Alternatives will be evaluated on the basis of the risk they create during the implementation of the remedy. Factors that may be considered include fire, explosion, and exposure of workers to hazardous substances.

   d. Implementability
   The alternatives will be evaluated for their implementability by considering any difficulties associated with conducting the alternatives (such as the construction disturbances they may create), operation of the alternatives, and the availability of equipment and resources to implement the technologies comprising the alternatives.

   e. Cost
   A net present value of each alternative will be developed. These cost estimates will be used for the relative evaluation of the alternatives, not to bid or budget the work. The estimates will be based on information available at the time of the CMS and on a conceptual design of the alternative. They will be "order-of-magnitude" estimates with a generally expected accuracy of -50 percent to +100 percent for the scope of action described for each alternative. The estimates will be categorized into capital costs and operations and maintenance costs for each alternative.

3.0 Description of Candidate Corrective Measure Alternatives

3.1 Introduction

Two candidate corrective measure alternatives are evaluated for this site:

- Alternative 1: Natural Attenuation with LUCs, and
- Alternative 2: In Situ Stabilization/Precipitation.

The sections below describe each alternative in detail.

3.2 Alternative 1: Natural Attenuation with Land Use Controls

3.2.1 Description of Alternative

Alternative 1 will allow the zinc to naturally attenuate in the subsurface, will impose LUCs (such as a deed restriction) to restrict the installation of drinking water wells, and will monitor groundwater concentrations periodically until the MCS is reached.

Information on groundwater flow (see Appendix A) indicates that groundwater flows generally to the north-northeast. Elevated concentrations of zinc that were detected at F617GW002 in 1997 appear to have migrated downgradient and are now in the area located near F617GW003 and F617GW006. The groundwater migration rate in this area was estimated in the original CMS report at approximately 0.1 ft/day (36 ft/year), based on hydrogeologic data available at that time. Based on the additional data generated during the pump test, the groundwater migration rate is estimated on the order of less than 10 ft/year.

Zinc is a relatively mobile heavy metal in groundwater at acidic and neutral pHs. As a conservative assumption, the maximum potential migration rate of zinc could be assumed to be close to the groundwater advection rate. Downgradient wells at the site include F617GW004, F617GW005, and FGELGW011. Zinc concentrations in these wells during the October 2002 sampling ranged from less than the detection limit to 601 μg/L, well below the target MCS of 11,000 μg/L, confirming that significant downgradient migration of zinc is not occurring.

3.2.2 Key Uncertainties

A key uncertainty identified in the *CMS Report, Revision 0* (CH2M-Jones, 2002) for the natural attenuation alternative is whether the zinc groundwater plume would discharge to a nearby water body, such as the Cooper River, by either direct discharge or via interception into a leaking storm sewer before the zinc had attenuated to concentrations that would not cause an unacceptable impact or risk to the environment. Another uncertainty identified in the original CMS report is whether the zinc plume might be intercepted by a leaking sanitary sewer at concentrations above the permitted sewer discharge standards.

An evaluation of the likely migration rate of zinc in groundwater in the *CMS Report, Revision 0* concluded that the expected migration rate was low enough not to cause unacceptable impacts to downgradient receptors. Based on the new information regarding the limited hydraulic conductivity of the aquifer and very low groundwater flow rates, it can be assumed that this evaluation remains valid. Monitoring of the zinc plume will ensure that unacceptable impacts to downgradient receptors are prevented.

As noted above, downgradient monitoring wells at the site include F617GW004, F617GW005, and FGELGW011. Zinc concentrations in these wells during the October 2002 sampling ranged from less than the detection limit to 601 $\mu g/L$, well below the target MCS of 11,000 $\mu g/L$, confirming that significant downgradient migration of zinc is not occurring.

3.2.3 Other Considerations

LUCs would be necessary to prevent installation of drinking water wells at AOC 617 until adequate attenuation of zinc had occurred. Periodic groundwater monitoring would also be necessary to ensure that unacceptable impacts to receptors are not occurring.

Based on the above considerations and availability of additional data that better characterize the affected aquifer, there appear to be very little opportunity for adverse environmental impacts to be caused by the slow migration and attenuation of the zinc plume. The minimal uncertainty associated with this alternative can be adequately addressed by periodic groundwater monitoring.

3.3 Alternative 2: In Situ Stabilization/Precipitation

3.3.1 Description of Alternative

Alternative 2 involves the injection of a stabilization or precipitation agent, such as a sulfide- or hydroxide-based material, to precipitate the zinc from the dissolved phase and into a solid phase. The precipitating material could be delivered to the aquifer via a variety of methods, including liquid or gas injection. Process and design parameters would need to be determined through the performance of bench-scale and, most likely, pilot-scale testing, before the feasibility of the approach is fully known.

3.3.2 Key Uncertainties

The greatest uncertainty is the long-term stability of the zinc precipitate. A process using a sulfide system may be sensitive to long-term changes in oxidation-reduction potential (ORP) in the groundwater. As long as the site stays under reducing conditions, the zinc would likely stay stable as a sulfide precipitate. If ORP increases, some conversion of the sulfide to sulfate is feasible, which may release some zinc into solution. Similarly, for a precipitation process based on hydroxide, a decrease in groundwater pH could result in a release of precipitated zinc back into the dissolved state.

It is also uncertain whether periodic injections of precipitating reagents might be needed to maintain the zinc concentrations below the MCS. In addition, the ideal precipitating agent and related chemical conditions, as well as the effectiveness of specific potential injection methods to deliver the reagents to the necessary areas, are unknown.

3.3.3 Other Considerations

Periodic monitoring of the groundwater zinc concentrations, pH, ORP, and other chemical parameters would be essential for measuring the effectiveness of Alternative 2. For the purpose of developing a representative cost estimate for this process, a precipitation process based on a lime slurry injection was assumed.

Based on the above considerations, there appear to be significant uncertainties that would need to be resolved to better understand the viability of this approach prior to its implementation.

Section 4.0

4.0 Evaluation and Comparison of Corrective Measure Alternatives

The two corrective measure alternatives were evaluated relative to the evaluative criteria described in Section 2.0 and then subjected to a comparative evaluation. A cost estimate for each alternative was also developed; the assumptions and unit costs used for these estimates are included in Appendix B.

4.1 Alternative 1: Natural Attenuation with Land Use Controls

The assumptions for Alternative 1 include the following:

- A base-wide land use control management plan (LUCMP) will be developed for the CNC. The plan will allow for restrictions on the use of groundwater at AOC 617 and other areas, and will be developed outside the scope of this CMS.
- Periodic groundwater monitoring will be performed for as long as necessary to ensure that adverse impacts to downgradient receptors do not occur. Samples will be collected from up to 10 groundwater wells on a semiannual basis initially and then annually thereafter.

4.1.1 Protection of Human Health and the Environment

This alternative is effective at protecting human health because it uses LUCs to prevent the ingestion of and direct contact with groundwater. With regard to protection of the environment, monitoring would need to be conducted to ensure that the zinc plume does not migrate into the Cooper River via direct discharge or by interception by a storm sewer, such that it could create unacceptable environmental impacts. If it does, additional active corrective measures would need to be implemented to preclude such impacts.

4.1.2 Attain MCS

This alternative is expected to eventually attain the MCS.

4.1.3 Control the Source of Releases

There are no ongoing sources of releases at AOC 617.

4.1.4 Compliance with Applicable Standards for the Management of Generated Wastes

Alternative 1 does not generate any wastes that require special management. The primary generated waste would be purge water from monitoring wells, which is easily managed to applicable standards.

4.1.5 Other Factors (a) Long-term Reliability and Effectiveness

Alternative 1 has adequate long-term reliability and effectiveness, provided that migration of the plume at unacceptable concentrations into surface water or the sanitary sewer does not occur. If such migration occurred, additional corrective measures may be necessary.

4.1.6 Other Factors (b) Reduction in the Toxicity, Mobility, or Volume of Wastes

Alternative 1 relies on natural attenuation to reduce the toxicity of the contaminated groundwater. This alternative does not reduce the mobility or volume of contaminated groundwater.

4.1.7 Other Factors (c) Short-term Effectiveness

Through the implementation of LUCs, Alternative 1 has short-term effectiveness in preventing ingestion of or contact with the contaminated groundwater. No significant short-term risks would be created using this alternative.

4.1.8 Other Factors (d) Implementability

Alternative 1 is easily implemented since it requires only the implementation of LUCs and an appropriate monitoring program.

4.1.9 Other Factors (e) Cost

Alternative 1 is the least costly to implement since it requires no construction of treatment facilities or disposal of wastes. The significant component of cost for this alternative is for groundwater monitoring.

Using the assumptions described earlier, the total present value of this alternative is $256,000.

4.2 Alternative 2: In Situ Stabilization/Precipitation

A presumptive approach of using a lime (hydroxide-based) precipitation process was assumed for evaluating this alternative. The following other assumptions were made:

- Quarterly groundwater monitoring would be performed at eight wells for a duration of 5 years.
- Semiannual groundwater monitoring would be performed at eight wells for a subsequent duration of 15 years.
- A yearly cost was included for the first 5 years for the injection of additional lime to better optimize zinc precipitation.

4.2.1 Protection of Human Health and the Environment

Alternative 2 is effective at protecting human health and the environment because it uses LUCs to prevent the ingestion of and direct contact with groundwater during the time period when groundwater zinc concentrations are greater than the MCS.

4.2.2 Attain MCS

It is unclear whether Alternative 2 will be able to permanently achieve the MCS. Additional injection of lime slurry may be needed if subsurface conditions (such as pH) change and cause the zinc to resolubilize. Using an effective precipitation process, the MCS could likely be achieved within 1 year after implementation.

4.2.3 Control the Source of Releases

There are no ongoing sources of releases at AOC 617; therefore, this issue is not applicable. Alternative 2would immobilize the zinc, precluding downgradient migration into uncontaminated groundwater.

4.2.4 Compliance with Applicable Standards for the Management of Generated Wastes

Alternative 2 does not generate any wastes that require special management.

4.2.5 Other Factors (a) Long-term Reliability and Effectiveness

Alternative 2 has long-term reliability because of the implementation of LUCs. Groundwater concentrations may rebound as zinc, which may be adsorbed to the aquifer matrix, slowly partitions into the groundwater. This may result in having to re-implement Alternative 2 after the first injection.

4.2.6 Other Factors (b) Reduction in the Toxicity, Mobility, or Volume of Wastes

Alternative 2 reduces the toxicity, mobility, and volume of the contaminated groundwater.

4.2.7 Other Factors (c) Short-term Effectiveness

Because of the implementation of LUCs, Alternative 2 will have short-term effectiveness in preventing ingestion of or contact with the contaminated groundwater. Because the precipitation reaction is relatively rapid, this alternative would have short-term effectiveness in precipitating the zinc into the solid phase. No unmanageable hazards would be created during its implementation.

4.2.8 Other Factors (d) Implementability

Alternative 2 may be moderately difficult to implement because of the problems inherent to the subsurface injection of the lime slurry, but could be performed without excessive difficulty.

4.2.9 Other Factors (e) Cost

A cost estimate was provided by ARS Technologies for the injection of lime slurry. Appendix B presents the overall cost estimate for implementing this remedy. A pilot test, prior to the design of the system, is also included in this cost estimate.

Using the cost estimate provided by ARS Technologies and the assumptions listed above, the total present value of Alternative 2 is $790,000. This cost estimate assumes that repeated injections of lime-slurry will be necessary to maintain proper subsurface conditions for the first 5 years.

4.4 Comparative Evaluation of Corrective Measure Alternatives

Each corrective measure alternative's overall ability to meet the evaluation criteria is described above. In Table 4-1, a comparative evaluation of the degree to which each alternative meets a particular criteria is presented.

TABLE 4-1
Comparative Evaluation of Corrective Measure Alternatives
Corrective Measures Study Report Addendum, AOC 617, Zone F, Charleston Naval Complex

Criterion	Alternative 1 Monitored Natural Attenuation	Alternative 2 In Situ Stabilization/Precipitation
Overall Protection of Human Health and the Environment	Protective of human health and the environment	Protective of human health and the environment
Attainment of MCS	Will eventually attain MCS via natural attenuation	Expected to attain MCS after treatment; long-term effectiveness unknown
Control of the source of releases	No ongoing source of release exists	No ongoing source of release exists
Compliance with applicable standards for the management of wastes	Can be implemented in compliance with applicable standards	Can be implemented in compliance with applicable standards
Long-term Reliability and Effectiveness	Expected to be reliable and effective in long term	Long-term reliability somewhat unknown
Reduction of Toxicity, Mobility, or Volume through Treatment	Does not directly reduce toxicity, mobility or volume	Reduces toxicity, mobility or volume
Short-term Effectiveness	Will be protective in the short term via LUCs	Expected to be effective in the short term
Implementability	Easily implemented	Moderately difficult to implement
Estimated Cost (in $1,000)	$256	$790

5.0 Recommended Corrective Measure Alternative

Two corrective measure alternatives were evaluated using the criteria described in Section 2.0 of this CMS report. These alternatives include: 1) Alternative 1: Natural Attenuation with LUCs; and 2) Alternative 2: In Situ Stabilization/Precipitation. The RAOs identified for groundwater at AOC 617 are: 1) to prevent ingestion and direct/dermal contact with groundwater having unacceptable carcinogenic or noncarcinogenic risk; 2) to prevent migration to offsite areas; and 3) to restore the aquifer to beneficial use.

Based on the alternatives evaluation and RAOs for the site and current uncertainties associated with each alternative, the preferred corrective measure alternative is Alternative 1: Natural Attenuation with LUCs. The RAO of preventing ingestion and direct/dermal contact with contaminated groundwater is achieved at a moderate cost. The second RAO exists because of potential ingestion or contact that could occur during intrusive site maintenance or if the plume migrates off site. Available data indicate that the expected rate of contamination migration is slow enough that no significant impacts to downgradient receptors are likely to occur without significant prior notice due to groundwater monitoring. The final RAO of restoring the aquifer to beneficial use will be met when the zinc concentrations in the aquifer are less than or equal to the MCS.

6.0 References

CH2M-Jones. *RFI Report Addendum and CMS Work Plan, AOCs 616/617, Zone F*. Revision 0. November 2001.

CH2M-Jones. *CMS Report for AOC 617*. Revision 0. February 2002.

EnSafe Inc. *Zone F RFI Report, NAVBASE Charleston*. Revision 0. December 31, 1997.

South Carolina Department of Health and Environmental Control (SCDHEC). RCRA Permit SC0 170 022 560. Charleston Naval Complex, Charleston, South Carolina. August 17, 1988.

South Carolina Department of Health and Environmental Control (SCDHEC). Comments on *Zone F RFI Report, Revision 0*. December 31, 1998.

Appendix A

NOTE: Original figure created in color

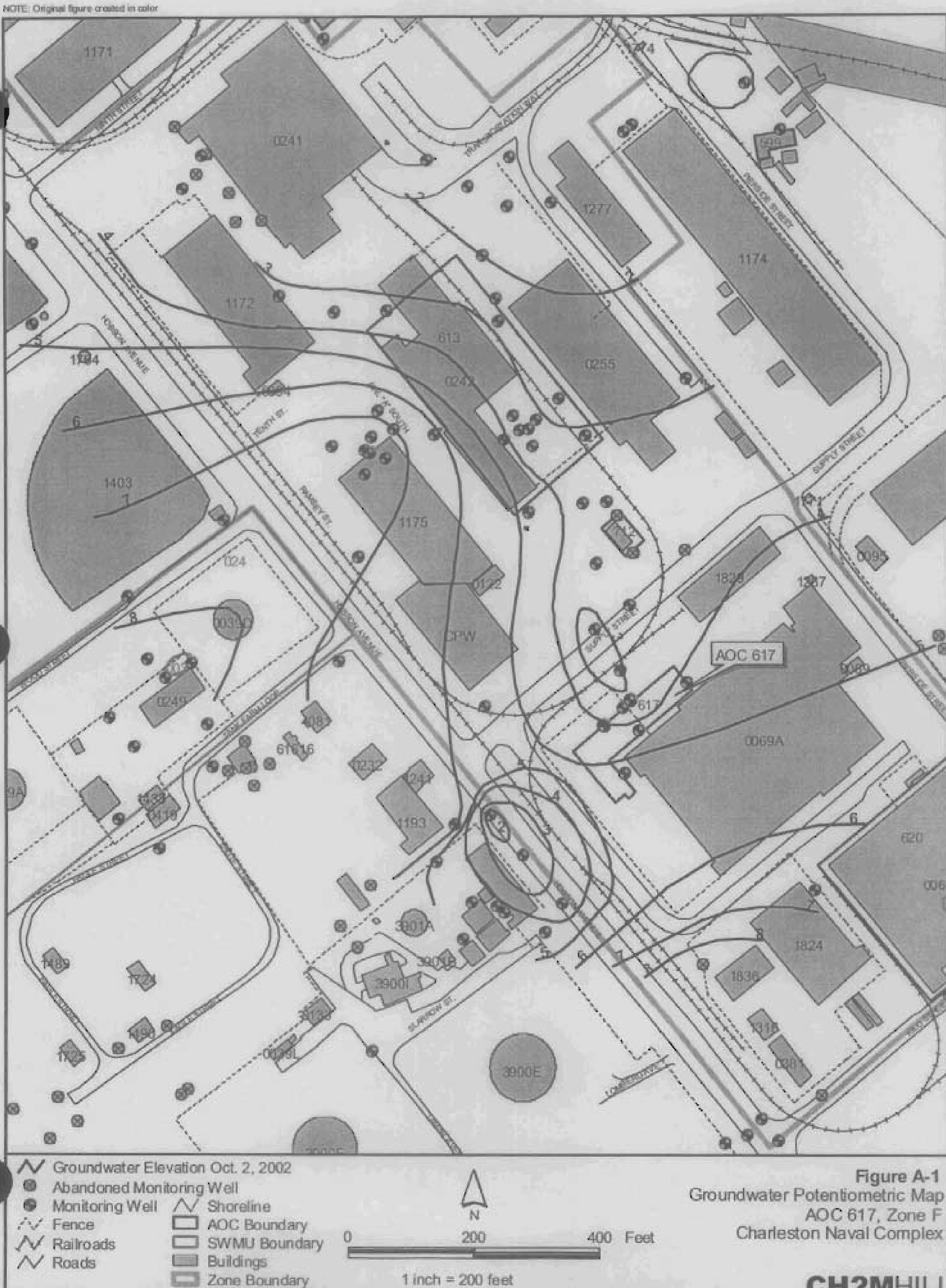


Figure A-1
Groundwater Potentiometric Map
AOC 617, Zone F
Charleston Naval Complex

CH2MHILL

File Path: c:\1figis\projects\zone_f\aoc617\aoc617.apr, Date: 19 Aug 2003 10:10, User: NMOUDRY, Figure D-1 Groundwater Potentiometric Map

COMPARISON OF TOTAL COST OF REMEDIAL SOLUTIONS

Site:	Charleston Naval Complex	**Base Year:**	2003
Location:	AOC 617	**Date:**	08/19/03
Phase:	Corrective Measures Study		

	Alternative Number 1	Alternative Number 2
Total Project Duration (Years)	30	20
Capital Cost	$12,700	$298,000
Annual O&M Cost	$13,000	$79,000 Yr 1-5 $19,200 Yr 6-20
Total Present Value of Solution	$256,000	$790,000

Disclaimer: The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This is an order-of-magnitude cost estimate that is expected to be within -50 to +100 percent of the actual project costs.

Alternative: **Number 2** — **COST ESTIMATE SUMMARY**
Elements: **In-Situ Stabilization**

Site: Charleston Naval Complex
Location: AOC 617
Phase: Corrective Measures Study
Base Year: 2003
Date: 02/01/02

Description:
Lime-slurry injection into shallow groundwater zone (5-10 ft bgs); effect will be to bring pH into optimal zone for zinc precipitation.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Initial Round of Water Levels	1	EA	$1,600	$1,600	See Water Levels Worksheet
Groundwater monitoring: quarterly of 4 wells for first year	16	EA	$500	$8,000	See Laboratory Worksheet
Pilot study	1	EA	$20,000	$20,000	ARS Technologies
Initial Lime-slurry injection	1	EA	$200,000	$200,000	ARS Technologies
SUBTOTAL				$229,600	
Contingency	20%		$229,600	$45,920	
SUBTOTAL				$275,520	
				$22,042	USEPA 2000, p. 5-13, $100K-$500K
Project Management	8%		$275,520		
Remedial Design	0%		$275,520	$0	Included in ARS estimate.
Construction Management	0%		$275,520	$0	Included in ARS estimate.
SUBTOTAL				$22,042	
TOTAL CAPITAL COST				$298,000	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Re-injection of additional lime-slurry	1	EA	$50,000	$50,000	
GW Monitoring: Qtly sampling of 8 wells for first five years; semi-annual sampling of 8 wells for subsequent 15 years	32	EA	$500	$16,000	See Laboratory Worksheet
SUBTOTAL				$66,000	
Allowance for Misc. Items	20%		$66,000	$13,200	
SUBTOTAL				$79,200	
TOTAL ANNUAL O&M COST				$79,000	

PRESENT VALUE ANALYSIS

Discount Rate = 3.2%

End Year	COST TYPE	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (3.2%)	PRESENT VALUE	NOTES
1	CAPITAL COST	$298,000	$298,000	1.000	$298,000	
5	ANNUAL O&M COST (Yr 1-5)	$79,000	$79,000	3.699	$292,252	
20	ANNUAL O&M COST (Yr 6-20)	$19,200	$19,200	10.374	$199,181	
					$789,433	
	TOTAL PRESENT VALUE OF ALTERNATIVE				$790,000	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: **Numbers 1,2,3**
Element: **Laboratory Costs**

Site: Charleston Naval Complex
Location: AOC 617
Phase: Corrective Measures Study
Base Year: 2003

Prepared By: RLC
Date:

Checked By:
Date:

WORK STATEMENT

Costs associated with water sample collection, shipment and analysis on a per event and per well basis.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Equipment & Labor per Event					
1 Liter Polypropylene	1	EA	$1	$1	CH2M-Jones Est.
Coolers	1	EA	$10	$10	CH2M-Jones Est.
Disposable Gloves	1	BOXES	$20	$20	CH2M-Jones Est.
Collection of samples	2	HR	$68	$136	CH2M-Jones Est.
Sample Shipment	1	EA	$20	$20	CH2M-Jones Est.
Sample Analysis (metals)	1	SAMPLE	$140	$140	GEL, PEL, STL average
Analysis of data	1	HR	$100	$100	CH2M-Jones Est.
SUBTOTAL				$427	
Allowance for Misc. Items	20%		$427	$85.40	
SUBTOTAL				$512	
TOTAL UNIT COST				$500	

OPERATION AND MAINTENANCE COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
SUBTOTAL				$0	
Allowance for Misc. Items	20%		$0	$0	
SUBTOTAL				$0	
TOTAL O&M COST				$0	

Source of Cost Data

1. Analytical Bid Form - Charleston Naval Complex - Level II

Appendix C

Aquifer Pump Test at Area of Concern (AOC) 617, Zone F, Charleston Naval Complex

PREPARED FOR: CNC BCT

PREPARED BY: Thomas Beisel, P.G., CH2M-Jones
Kim-Lee Murphy, CH2M-Jones
Dean Williamson, CH2M-Jones

DATE: June 26, 2003

Introduction

The remedial alternative recommended in the Corrective Measures Study (CMS) Report for zinc-contaminated groundwater for Area of Concern (AOC) 617 in Zone F of the Charleston Naval Complex (CNC) was groundwater extraction, treatment and discharge to the sanitary sewer.

To determine the viability of this remedial alternative, a step-drawdown pump test and a constant rate pump test were performed between November 5 and November 14, 2002. The objectives of the aquifer tests were to:

- Determine the transmissive and storage properties of the surficial aquifer at AOC 617
- Determine the long-term sustainable groundwater recovery rate,
- Characterize the quality of the extracted groundwater, and
- Observe any short term changes in zinc concentrations and pH in recovered groundwater.

Newly installed well, F617GW006, was used as the groundwater extraction well. This well is a 4-inch-diameter well installed to a depth of 15 feet below land surface (bls). Four observation wells (F617GW003, F617GW03D, F617GW007, and F617GW07D), located within 30 feet of the extraction well, were monitored during the constant rate pump test. Well completion data for newly installed wells are summarized in **Table 1**. Well locations are presented in **Figure 1**. Lithologic logs and well completion reports for new wells are also included with this memorandum as **Appendix B.**

The work plan describing the overall approach to the pump test was approved by EPA on behalf of DHEC on October 22, 2002.

Aquifer Testing

Step-Drawdown Test

On November 5, 2002 a step-drawdown test was initiated in extraction well, F617GW006, to determine the maximum extraction rate achievable without inducing adverse drawdown effects within the extraction well. Prior to start of the step-drawdown test, the static water level was measured in site monitoring wells to determine baseline conditions. A pressure transducer and Grundfos submersible pump were lowered into the extraction well and the pressure transducer was connected to a Hermit 3000 for data logging. The step-drawdown test was initiated at 0.40 gpm and quickly reduced to 0.25 gpm. However, the step-test was prematurely ended due excessive drawdown. Water levels were allowed to recover to within 95 percent of the initial water levels; recovery data was collected for 15.7 hours. Changes in atmospheric pressure were monitored during the test.

The step-drawdown test was re-attempted on November 6, 2002. The first step was set at 0.25 gpm and run for 49 minutes; water levels in the well appeared to equilibrate within this time period. The drawdown measured after this step was 7.4 feet and the specific capacity was calculated 0.03 gpm/ft. Water levels were allowed to recover before running additional steps. The pump and transducer were also lowered 1 foot deeper into the well.

Since the well yield was much lower than expected, the flow rate for the second step was reduced, in order to run a series of continuous steps which could help determine an achievable flow rate. Approximately 2 hours after completion of step 1, step 2 was initiated at 0.08 (300mL/min) gpm for approximately 45 minutes. The following 3 steps were run consecutively. Step 3 was run at 0.13 gpm (500 mL/min) and for approximately 52 minutes; Step 4 was run at 0.17 gpm (650 mL/min) for 40 minutes; and Step 5 was run at 0.20 gpm (750 mL/min) for 16 minutes. During the last step, the water level dropped to the top of the pump and the step-test was concluded. A plot of the step test data is provided as **Figures 2A** and **2B**.

Constant Rate and Recovery Test

On November 12, 2002, pressure transducers were lowered into the extraction well, F617GW006, two shallow observation wells (F617GW003 and F617GW005) and two deep observation wells (F617GW03D and F617GW05D) in preparation for the constant rate test. Well completion data are summarized in Table 1 and well locations are presented in Figure 1. All transducers were connected to the Hermit 3000 data logger. The following static water levels were recorded in each well prior to the test.

Well	Depth to Water (ft)	Water Column Thickness (ft H2O)
F617GW006	5.79	10.3
F617GW003	6.68	6.8
F617GW03D	6.41	17.2
F617GW005	6.96	13.6
F617GW05D	8.68	20.5

The constant rate pump test was performed at a flow rate of 0.13 gpm (500mL/min). Water levels during the pump test were measured periodically by hand and with the data logger, which was set up in logarithmic mode. Because the pump had difficulty maintaining the low flow rate under the given pressure head, the pump controller had to be frequently re-adjusted. Approximately 6 hours into the pump test, the water column above the pressure transducer dropped below a thickness of 2 feet and was continuing to drop, indicating that the water levels would not stabilize before exposing the pump, which was located above the transducer. The pump was stopped and well recovery data was recorded in all wells until the next morning. Water levels in all wells recovered within 95 percent of the static values. A plot of the pump test and recovery data is provided as **Figures 3A** and **3B**.

Aquifer Test Effluent Sampling

An effluent grab sample (617GW001M3) from F617GW006 was collected during the 6-hour constant rate test on November 12, 2002 for a complete inorganic analysis of cations (including metals) and anions. Samples for dissolved metals were filtered prior to collection. Laboratory analytical results are summarized in **Table 2**. Total zinc was reported at 264,000 μg/L and dissolved zinc was reported at 263,000 μg/L, above the media cleanup standard (MCS) of 11,000 μg/L.

Aquifer Test Analysis

Due to the heavy precipitation (rainfall) which occurred around the time of the pump test, only data for extraction well F617GW006 and observation well F617GW03D were analyzed for aquifer parameters. Water level data in the other three observations wells were sporadic and generally on an increasing trend (see **Figure 3A**). Therefore, any impact, if any, that the pump test may have had on these wells appears to be lower than the rate of recharge due to the rain. Further, considering the site cover is asphalt, the steady increase in water levels in the shallow wells indicate that storm water lines located nearby may be a source of the infiltration.

The pump test and recovery data for wells F617GW006 and F617GW03D were analyzed using the AquiferTest software, created by Waterloo Hydrogeologic, Inc. All plotted analyses and data are provided in **Attachment A**.

F617GW006

The F617GW006 well pumping test data was analyzed using the Cooper-Jacob straight-line method and recovery data was analyzed using the Theis and Jacob recovery method. An aquifer thickness of 30 feet was assumed based on the AOC 617 Zinc Source Area Assessment and Aquifer Pump Test; Sampling and Analysis Plan. The average hydraulic conductivity was 2.19E-05 ft/min (11.5 ft/year). **Table 3** summarizes all the aquifer test analyses.

F617GW03D

Since F617GW03D is assumed to be under semi-confining conditions, the observation well data taken during the aquifer pump test was analyzed using the Cooper-Jacob straight-line method, the Moench method (for a partially penetrating well), and the Hantush method (for leaky semi-confined aquifer). Recovery data was analyzed using the Theis and Jacob recovery method. During the Hantush analysis, water levels from the observation well did not deviate from the Theis curve. This indicates no or very little leakance, which would recharge this zone. The average hydraulic conductivity for all methods was 1.40E-04 ft/min (73.4 ft/yr). Values ranged from 9.04E-5 ft/min to 1.63E-4 ft/min. **Table 3** summarizes all the aquifer test analyses.

Analyses using the Cooper-Jacob , Theis, and Theis and Jacob Recovery method were corrected for an unconfined aquifer. Results using the recovery test method for both wells were lower than results from the other methods and results from the Moench method, reported the highest value. Since the recovery data is based on the largest data set and assumed to be more consistent (not influenced by problematic flow rate), the hydraulic conductivity for the site is assumed to be closer to these values. This is supported by the low well yield obtained during the step-drawdown test. However, due to partial penetration of the wells in the surficial aquifer, hydraulic conductivity values are probably slightly higher than the values reported from the recovery method.

Investigative-Derived Waste

Groundwater recovered during the aquifer pump tests was collected as investigation-derived waste (IDW), tested, and disposed of off site at a permitted treatment facility. Extracted water was stored on-site in a 20,000 gallon frac tank prior to disposal.

Groundwater Sampling for New Wells

Groundwater samples were collected from the newly installed wells at AOC 617 and analyzed for metals and other general parameters. A summary of detected chemicals is presented in Table X.

Conclusions

A step-drawdown test and 6-hour constant rate aquifer test were performed at AOC 617 in November 2002 for the surficial aquifer. The step-drawdown test indicated that the upper zone of the surficial aquifer is very tight and an extraction well installed in this zone will produce only a small inadequate yield.

The constant rate pump test was prematurely ended at 6 hours due to a steep cone of depression, which was about to intersect the extraction pump, at an extremely low flow rate (500 mL/min). Due to the unexpected shortness of the pump test, no observations could be made regarding changes in zinc concentrations or other groundwater parameters over time. Based on the pumping and recovery data, the hydraulic conductivity within the upper zone of the surficial aquifer is approximately 11.5 ft/yr. Due to weather conditions, data from observation wells screened in this same zone was inconclusive unfortunately. However, a slight influence was recorded in an observation well located in the lower zone of the surficial aquifer.

The constant rate pump test indicated that a groundwater extraction rate of 500 mL/min or even lower would create unacceptable drawdown in the extraction well, creating large drawdown over a small radius of influence. Assuming a rate of 500 mL/min could even be achieved, less than 200 gallons of zinc contaminated groundwater could be recovered per day. At this rate, groundwater extraction would be an inefficient remedy. Therefore, groundwater extraction, treatment, and disposal does not appear to be a viable alternative for remediation at this site.

TABLE 1
Well Construction Details
AOC 617, Zone F, CNC

Well ID	Well Diameter (in)	Total Depth (ft)	Screen Interval (ft bls)
F617GW003	2	15	5
F617GW03D	4	30	20-30
F617GW005	4	17.08	7-17
F617GW05D	4	30.41	20-30
F617GW006	4	15	5-15

in inch
ft bls feet below land surface

TABLE 2
Summary of Analytical Results (November 12, 2002); Well G617GW006 (test recovery well)
AOC 617, Zone F, CNC

Parameter	Unit	617GA001M3
Metals, total		
Aluminum	µg/L	14,500 =
Arsenic	µg/L	6.48 =
Barium	µg/L	61.6 =
Cadmium	µg/L	46.9 =
Calcium	µg/L	387,000 =
Chromium, Total	µg/L	2.66 U
Copper	µg/L	8.9 =
Iron	µg/L	287,000 =
Lead	µg/L	2.84 U
Magnesium	µg/L	117,000 =
Manganese	µg/L	3,460 =
Mercury	µg/L	0.039 U
Nickel	µg/L	858 =
Potassium	µg/L	16,100 =
Selenium	µg/L	2.67 U
Silica	µg/L	46,100 J
Silver	µg/L	5.75 U
Sodium	µg/L	769,000 =
Strontium	µg/L	1,360 =
Zinc	µg/L	264,000 J
Metals, dissolved		
Aluminum, Dissolved	µg/L	7,460 =
Arsenic, Dissolved	µg/L	7.21 =
Barium, Dissolved	µg/L	61.2 =
Cadmium, Dissolved	µg/L	47.3 =
Calcium, Dissolved	µg/L	386,000 =
Chromium, Dissolved	µg/L	2.66 U
Copper, Dissolved	µg/L	1.3 U

TABLE 2
Summary of Analytical Results (November 12, 2002); Well G617GW006 (test recovery well)
AOC 617, Zone F, CNC

Parameter	Unit	617GA001M3
Iron, Dissolved	µg/L	284,000 =
Lead, Dissolved	µg/L	1.43 U
Magnesium, Dissolved	µg/L	117,000 =
Manganese, Dissolved	µg/L	3,490 =
Mercury, Dissolved	µg/L	0.039 U
Nickel, Dissolved	µg/L	861 =
Potassium, Dissolved	µg/L	16,100 =
Selenium, Dissolved	µg/L	2.67 U
Silica, Dissolved	µg/L	43,700 J
Silver, Dissolved	µg/L	5.75 U
Sodium, Dissolved	µg/L	765,000 =
Strontium, Dissolved	µg/L	1,380 =
Zinc, Dissolved	µg/L	263,000 J
Other		
Alkalinity, Total (as CaCO3)	mg/L	2.1 =
Chloride	mg/L	890 =
Cyanide	µg/L	5 U
Fluoride	mg/L	2.73 =
Nitrite (as N)	mg/L	0.1 U
Nitrogen, Ammonia (as N)	mg/L	16.1 =
Nitrogen, Nitrate (as N)	mg/L	0.1 U
Ortho-phosphate	mg/L	0.05 U
pH	SU	4.89 =
Phosphorus	mg/L	0.0407 J
Sulfate (as SO4)	mg/L	2,700 =
Sulfide	mg/L	0.05 UJ
Total Dissolved Solids (Residue, filterable)	mg/L	4,950 =
Total Suspended Solids (TSS)	mg/L	63.1 =

mg/L milligrams per liter
µg/L micrograms per liter

TABLE 3
Summary of Aquifer Test Analysis
AOC 617, Zone F, CNC

Analysis Method[2]	Hydraulic Conductivity[1]	
	ft/min	ft/yr
F617GW006		
Cooper-Jacob	3.32E-05	17.5
Recovery	1.06E-05	5.6
AVERAGE	2.19E-05	11.5
F617GW03D		
Cooper-Jacob	1.60E-04	84.1
Hantush	1.45E-04	76.2
Moench	1.63E-04	85.7
Recovery	9.04E-05	47.5
AVERAGE	1.40E-04	73.4

1. Assumes an aquifer thickness of 30 feet.
2. All methods adjusted for unconfined aquifer , except Hantush method.

FIGURE 2A
Results of Step 1 in Step-Drawdown Test

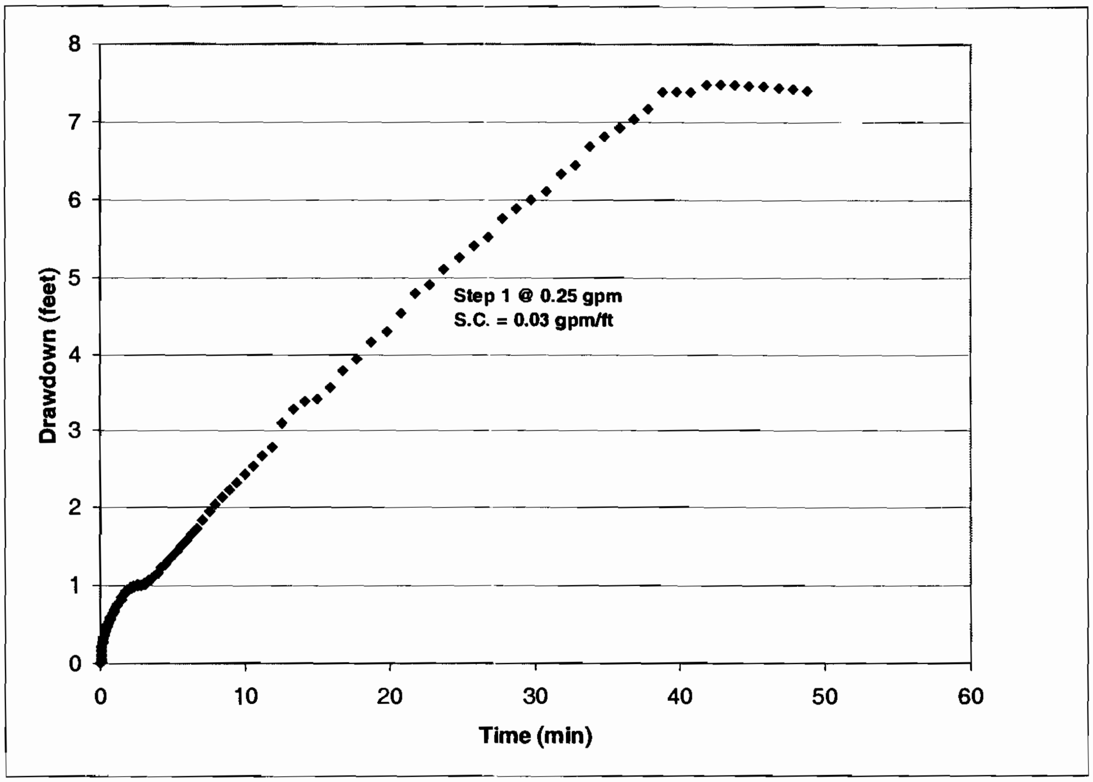


FIGURE 2B
Results of Steps 2 through 5 in Step-Drawdown Test

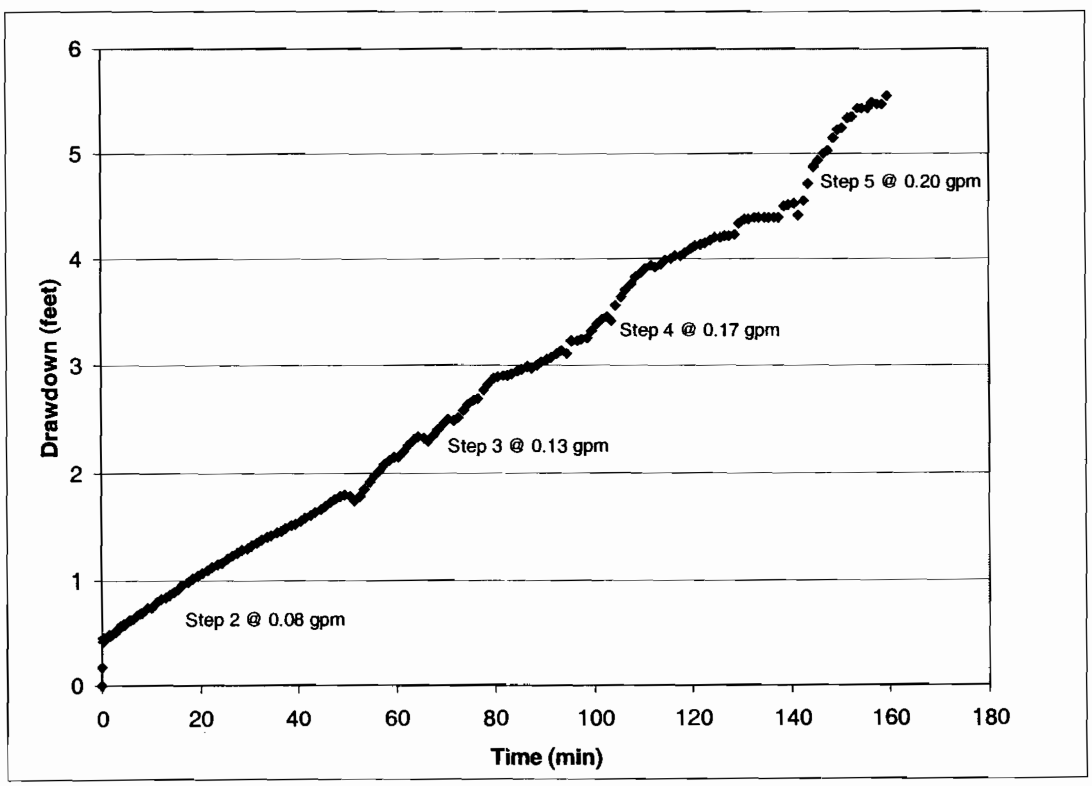


FIGURE 3A
Results of Constant Rate Pump Test in F617GW003, F617GW005, and F617GW05D

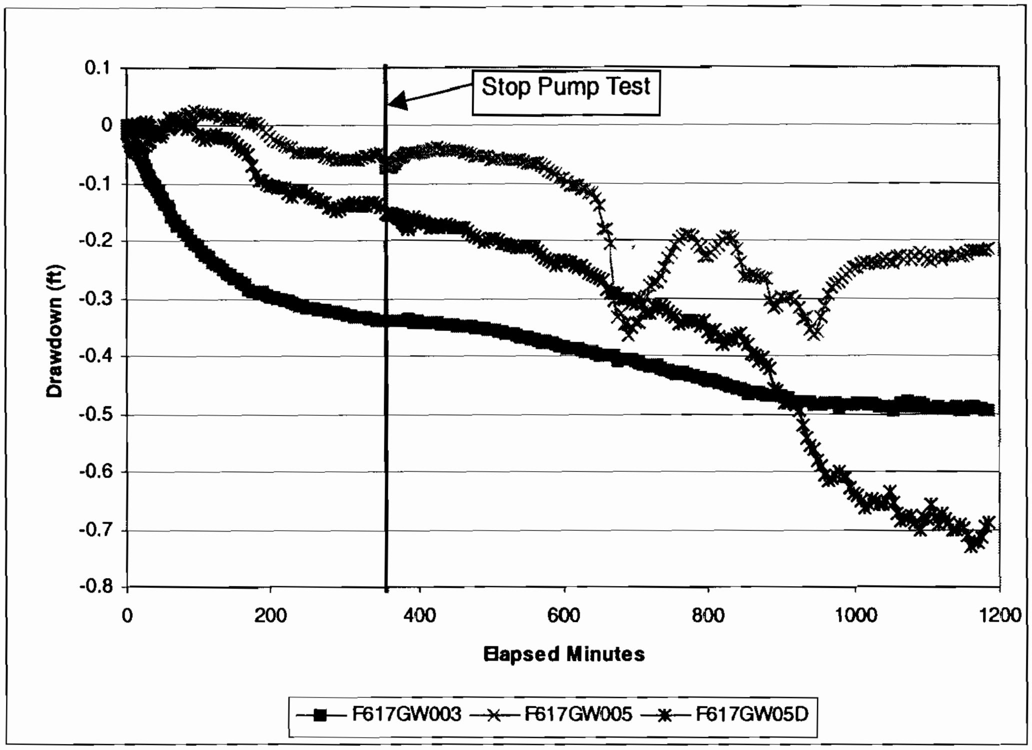
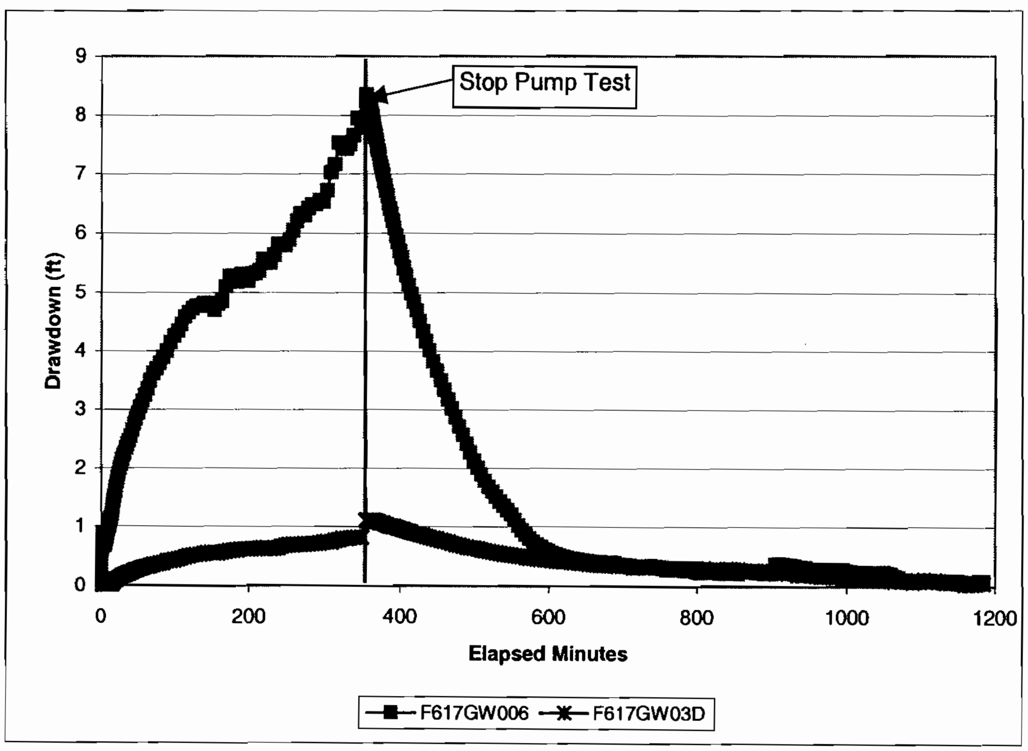


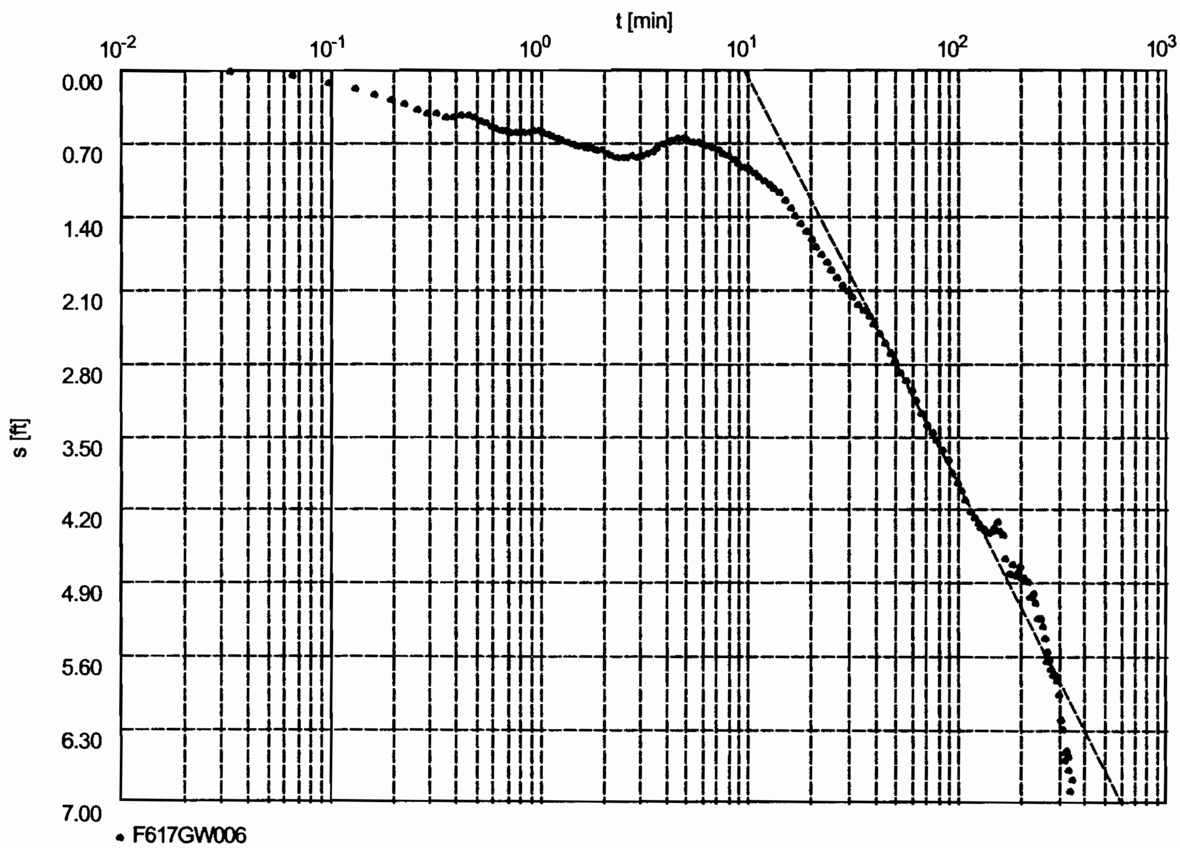
FIGURE 3B
Results of Constant Rate Pump Test in F617GW03D and F617GW006



Attachment A: Aquifer Test Analyses

CH2M-Jones	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	Date: 11/14/02	Page 1
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW006	
Discharge 0.13 U.S.gal/min	



Transmissivity [ft²/min]: 8.17×10^{-4}

Hydraulic conductivity [ft/min]: 2.72×10^{-5}

Aquifer thickness [ft]: 30.00

CH2M-Jones	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	Date: 11/14/02	Page 2
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW006	F617GW006
Discharge 0.13 U.S.gal/min	Distance from the pumping well 0.33 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
2	0.03	0.01	0.01	0.01
3	0.07	0.06	0.06	0.06
4	0.10	0.13	0.13	0.13
5	0.13	0.19	0.19	0.19
6	0.16	0.25	0.25	0.25
7	0.20	0.30	0.30	0.30
8	0.23	0.34	0.34	0.34
9	0.26	0.39	0.39	0.39
10	0.30	0.42	0.42	0.42
11	0.33	0.43	0.43	0.43
12	0.36	0.46	0.46	0.45
13	0.39	0.46	0.46	0.45
14	0.43	0.45	0.45	0.45
15	0.46	0.45	0.45	0.44
16	0.49	0.47	0.47	0.47
17	0.53	0.50	0.50	0.49
18	0.56	0.53	0.53	0.5[illegible]
19	0.59	0.55	0.55	0.5[illegible]
20	0.62	0.57	0.57	0.56
21	0.66	0.59	0.59	0.58
22	0.69	0.60	0.60	0.59
23	0.73	0.61	0.61	0.60
24	0.76	0.61	0.61	0.61
25	0.80	0.62	0.62	0.61
26	0.84	0.61	0.61	0.61
27	0.89	0.61	0.61	0.60
28	0.94	0.60	0.60	0.60
29	0.98	0.61	0.61	0.60
30	1.04	0.61	0.61	0.61
31	1.09	0.64	0.64	0.63
32	1.15	0.65	0.65	0.65
33	1.22	0.67	0.67	0.66
34	1.28	0.69	0.69	0.69
35	1.35	0.71	0.71	0.70
36	1.43	0.73	0.73	0.72
37	1.51	0.74	0.74	0.73
38	1.59	0.75	0.75	0.74
39	1.68	0.76	0.76	0.75
40	1.77	0.77	0.77	0.76
41	1.87	0.78	0.78	0.77
42	1.98	0.79	0.79	0.78
43	2.09	0.82	0.82	0.81
44	2.21	0.84	0.84	0.83
45	2.33	0.86	0.86	0.8[illegible]
46	2.46	0.87	0.87	0.8[illegible]
47	2.60	0.85	0.85	0.84
48	2.75	0.85	0.85	0.83
49	2.91	0.85	0.85	0.84
50	3.08	0.84	0.84	0.83

CH2M-Jones	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	Date: 11/14/02	Page 3
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW006	F617GW006
Discharge 0.13 U.S.gal/min	Distance from the pumping well 0.33 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
51	3.25	0.82	0.82	0.81
52	3.44	0.80	0.80	0.79
53	3.64	0.76	0.76	0.75
54	3.85	0.73	0.73	0.72
55	4.07	0.71	0.71	0.70
56	4.31	0.69	0.69	0.68
57	4.56	0.68	0.68	0.67
58	4.82	0.68	0.68	0.67
59	5.10	0.68	0.68	0.68
60	5.40	0.70	0.70	0.69
61	5.71	0.72	0.72	0.71
62	6.05	0.73	0.73	0.72
63	6.40	0.75	0.75	0.74
64	6.77	0.77	0.77	0.76
65	7.17	0.79	0.79	0.78
66	7.59	0.82	0.82	0.81
67	8.03	0.85	0.85	0.84
68	8.50	0.88	0.88	0.87
69	9.00	0.91	0.91	0.90
70	9.53	0.95	0.95	0.94
71	10.09	0.98	0.98	0.97
72	10.68	1.02	1.02	1.00
73	11.31	1.06	1.06	1.04
74	11.98	1.09	1.09	1.07
75	12.68	1.12	1.12	1.10
76	13.43	1.16	1.16	1.14
77	14.22	1.20	1.20	1.18
78	15.05	1.29	1.29	1.26
79	15.94	1.36	1.36	1.33
80	16.88	1.44	1.44	1.40
81	17.87	1.51	1.51	1.47
82	18.93	1.59	1.59	1.55
83	20.04	1.68	1.68	1.63
84	21.22	1.75	1.75	1.70
85	22.48	1.83	1.83	1.77
86	23.80	1.91	1.91	1.85
87	25.21	1.99	1.99	1.92
88	26.70	2.06	2.06	1.99
89	28.27	2.14	2.14	2.06
90	29.94	2.21	2.21	2.13
91	31.71	2.26	2.26	2.17
92	33.58	2.34	2.34	2.25
93	35.57	2.41	2.41	2.31
94	37.67	2.47	2.47	2.37
95	39.90	2.54	2.54	2.44
96	42.26	2.65	2.65	2.53
97	44.76	2.75	2.75	2.63
98	47.40	2.84	2.84	2.71
99	50.21	2.94	2.94	2.79
100	53.18	3.05	3.05	2.89

CH2M-Jones	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	Date: 11/14/02	Page 4
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW006	F617GW006
Discharge 0.13 U.S.gal/min	Distance from the pumping well 0.33 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
101	56.32	3.14	3.14	2.98
102	59.65	3.24	3.24	3.06
103	63.18	3.35	3.35	3.16
104	66.92	3.49	3.49	3.29
105	70.88	3.62	3.62	3.40
106	75.08	3.69	3.69	3.47
107	79.52	3.79	3.79	3.55
108	84.23	3.88	3.88	3.63
109	89.21	4.00	4.00	3.73
110	94.21	4.14	4.14	3.86
111	99.21	4.26	4.26	3.95
112	104.21	4.34	4.34	4.03
113	109.21	4.45	4.45	4.12
114	114.21	4.58	4.58	4.23
115	119.21	4.65	4.65	4.29
116	124.21	4.72	4.72	4.35
117	129.21	4.76	4.76	4.38
118	134.21	4.77	4.77	4.3[illegible]
119	139.21	4.81	4.81	4.4
120	144.21	4.81	4.81	4.42
121	149.21	4.76	4.76	4.38
122	154.21	4.70	4.70	4.33
123	159.21	4.80	4.80	4.42
124	164.21	4.85	4.85	4.46
125	169.21	5.10	5.10	4.67
126	174.21	5.28	5.28	4.81
127	179.21	5.29	5.29	4.83
128	184.21	5.18	5.18	4.74
129	189.21	5.32	5.32	4.85
130	194.21	5.26	5.26	4.80
131	199.21	5.20	5.20	4.75
132	204.21	5.32	5.32	4.85
133	209.21	5.34	5.34	4.86
134	214.21	5.38	5.38	4.89
135	219.21	5.56	5.56	5.05
136	224.21	5.55	5.55	5.03
137	229.21	5.51	5.51	5.01
138	234.21	5.63	5.63	5.10
139	239.21	5.81	5.81	5.25
140	244.21	5.81	5.81	5.24
141	249.21	5.81	5.81	5.24
142	254.21	5.89	5.89	5.31
143	259.21	6.04	6.04	5.44
144	264.21	6.20	6.20	5.56
145	269.21	6.33	6.33	5.6[illegible]
146	274.21	6.30	6.30	5.6
147	279.21	6.41	6.41	5.73
148	284.21	6.48	6.48	5.78
149	289.21	6.49	6.49	5.78
150	294.21	6.56	6.56	5.84

CH2M-Jones	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	Date: 11/14/02	Page 5
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW006	F617GW006
Discharge 0.13 U.S.gal/min	Distance from the pumping well 0.33 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
151	299.21	6.53	6.53	5.82
152	304.21	6.72	6.72	5.97
153	309.21	7.03	7.03	6.20
154	314.21	7.16	7.16	6.30
155	319.21	7.54	7.54	6.59
156	324.21	7.45	7.45	6.52
157	329.21	7.43	7.43	6.51
158	334.21	7.50	7.50	6.56
159	339.21	7.66	7.66	6.68
160	344.21	7.95	7.95	6.90
161	349.21	7.79	7.79	6.78

CH2M-Jones	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	Date: 11/14/02	Page 6
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW006	F617GW006
Discharge 0.13 U.S.gal/min	

	Discharge [U.S.gal/min]	Water level below datum [ft]	Drawdown [ft]	
1	0.00	0.00	0.00	
2	0.00	0.01	0.01	
3	0.01	0.06	0.06	
4	0.01	0.13	0.13	
5	0.02	0.19	0.19	
6	0.02	0.25	0.25	
7	0.03	0.30	0.30	
8	0.03	0.34	0.34	
9	0.03	0.39	0.39	
10	0.04	0.42	0.42	
11	0.04	0.43	0.43	
12	0.05	0.46	0.46	
13	0.05	0.46	0.46	
14	0.06	0.45	0.45	
15	0.06	0.45	0.45	
16	0.07	0.47	0.47	
17	0.07	0.50	0.50	
18	0.07	0.53	0.53	
19	0.08	0.55	0.55	
20	0.08	0.57	0.57	
21	0.09	0.59	0.59	
22	0.09	0.60	0.60	
23	0.10	0.61	0.61	
24	0.10	0.61	0.61	
25	0.11	0.62	0.62	
26	0.11	0.61	0.61	
27	0.12	0.61	0.61	
28	0.12	0.60	0.60	
29	0.13	0.61	0.61	
30	0.14	0.61	0.61	
31	0.14	0.64	0.64	
32	0.15	0.65	0.65	
33	0.16	0.67	0.67	
34	0.17	0.69	0.69	
35	0.18	0.71	0.71	
36	0.19	0.73	0.73	
37	0.20	0.74	0.74	
38	0.21	0.75	0.75	
39	0.22	0.76	0.76	
40	0.23	0.77	0.77	
41	0.25	0.78	0.78	
42	0.26	0.79	0.79	
43	0.28	0.82	0.82	
44	0.29	0.84	0.84	
45	0.31	0.86	0.86	
46	0.33	0.87	0.87	
47	0.34	0.85	0.85	
48	0.36	0.85	0.85	
49	0.38	0.85	0.85	
50	0.41	0.84	0.84	

CH2M-Jones	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	Date: 11/14/02	Page 7
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW006	F617GW006
Discharge 0.13 U.S.gal/min	

	Discharge [U.S.gal/min]	Water level below datum [ft]	Drawdown [ft]	
51	0.43	0.82	0.82	
52	0.45	0.80	0.80	
53	0.48	0.76	0.76	
54	0.51	0.73	0.73	
55	0.54	0.71	0.71	
56	0.57	0.69	0.69	
57	0.60	0.68	0.68	
58	0.64	0.68	0.68	
59	0.67	0.68	0.68	
60	0.71	0.70	0.70	
61	0.75	0.72	0.72	
62	0.80	0.73	0.73	
63	0.84	0.75	0.75	
64	0.89	0.77	0.77	
65	0.95	0.79	0.79	
66	1.00	0.82	0.82	
67	1.06	0.85	0.85	
68	1.12	0.88	0.88	
69	1.19	0.91	0.91	
70	1.26	0.95	0.95	
71	1.33	0.98	0.98	
72	1.41	1.02	1.02	
73	1.49	1.06	1.06	
74	1.58	1.09	1.09	
75	1.67	1.12	1.12	
76	1.77	1.16	1.16	
77	1.88	1.20	1.20	
78	1.99	1.29	1.29	
79	2.10	1.36	1.36	
80	2.23	1.44	1.44	
81	2.36	1.51	1.51	
82	2.50	1.59	1.59	
83	2.65	1.68	1.68	
84	2.80	1.75	1.75	
85	2.97	1.83	1.83	
86	3.14	1.91	1.91	
87	3.33	1.99	1.99	
88	3.52	2.06	2.06	
89	3.73	2.14	2.14	
90	3.95	2.21	2.21	
91	4.19	2.26	2.26	
92	4.43	2.34	2.34	
93	4.70	2.41	2.41	
94	4.97	2.47	2.47	
95	5.27	2.54	2.54	
96	5.58	2.65	2.65	
97	5.91	2.75	2.75	
98	6.26	2.84	2.84	
99	6.63	2.94	2.94	
100	7.02	3.05	3.05	

CH2M-Jones	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	Date: 11/14/02	Page 8
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW006	F617GW006
Discharge 0.13 U.S.gal/min	

	Discharge [U.S.gal/min]	Water level below datum [ft]	Drawdown [ft]	
101	7.43	3.14	3.14	
102	7.87	3.24	3.24	
103	8.34	3.35	3.35	
104	8.83	3.49	3.49	
105	9.36	3.62	3.62	
106	9.91	3.69	3.69	
107	10.50	3.79	3.79	
108	11.12	3.88	3.88	
109	11.78	4.00	4.00	
110	12.44	4.14	4.14	
111	13.10	4.26	4.26	
112	13.76	4.34	4.34	
113	14.42	4.45	4.45	
114	15.08	4.58	4.58	
115	15.74	4.65	4.65	
116	16.40	4.72	4.72	
117	17.06	4.76	4.76	
118	17.72	4.77	4.77	
119	18.38	4.81	4.81	
120	19.04	4.81	4.81	
121	19.70	4.76	4.76	
122	20.36	4.70	4.70	
123	21.02	4.80	4.80	
124	21.68	4.85	4.85	
125	22.34	5.10	5.10	
126	23.00	5.28	5.28	
127	23.66	5.29	5.29	
128	24.32	5.18	5.18	
129	24.98	5.32	5.32	
130	25.64	5.26	5.26	
131	26.30	5.20	5.20	
132	26.96	5.32	5.32	
133	27.62	5.34	5.34	
134	28.28	5.38	5.38	
135	28.94	5.56	5.56	
136	29.60	5.55	5.55	
137	30.26	5.51	5.51	
138	30.92	5.63	5.63	
139	31.58	5.81	5.81	
140	32.24	5.81	5.81	
141	32.90	5.81	5.81	
142	33.56	5.89	5.89	
143	34.22	6.04	6.04	
144	34.88	6.20	6.20	
145	35.54	6.33	6.33	
146	36.20	6.30	6.30	
147	36.86	6.41	6.41	
148	37.52	6.48	6.48	
149	38.18	6.49	6.49	
150	38.84	6.56	6.56	

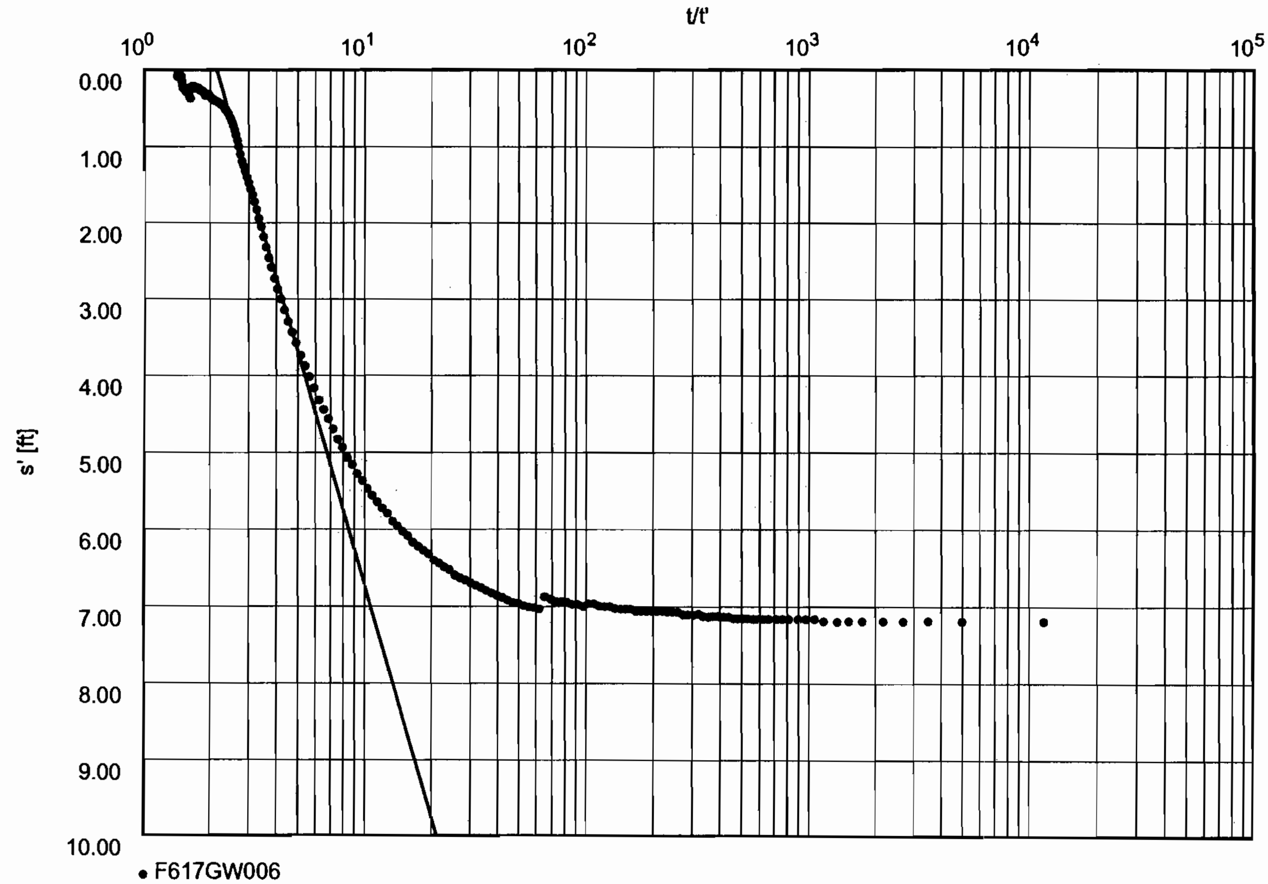
CH2M-Jones	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	Date: 11/14/02	Page 9
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW006	F617GW006
Discharge 0.13 U.S.gal/min	

	Discharge [U.S.gal/min]	Water level below datum [ft]	Drawdown [ft]	
151	39.50	6.53	6.53	
152	40.16	6.72	6.72	
153	40.82	7.03	7.03	
154	41.48	7.16	7.16	
155	42.14	7.54	7.54	
156	42.80	7.45	7.45	
157	43.46	7.43	7.43	
158	44.12	7.50	7.50	
159	44.78	7.66	7.66	
160	45.44	7.95	7.95	
161	46.10	7.79	7.79	

CH2M-Jones	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	Date: 11/14/02	Page 1
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW006	
Discharge 0.13 U.S.gal/min	
	Pumping test duration: 349.00 min



Transmissivity [ft²/min]: 3.20×10^{-4}

Hydraulic conductivity [ft/min]: 1.06×10^{-5}

Aquifer thickness [ft]: 30.00

CH2M-Jones	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	Date: 11/14/02	Page 2
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW006	F617GW006
Discharge 0.13 U.S.gal/min	
Static water level: 0.00 ft below datum	Pumping test duration: 349.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
2	0.03	8.35	8.35	7.19
3	0.07	8.35	8.35	7.19
4	0.10	8.35	8.35	7.19
5	0.13	8.35	8.35	7.19
6	0.16	8.35	8.35	7.19
7	0.20	8.35	8.35	7.19
8	0.23	8.35	8.35	7.19
9	0.26	8.35	8.35	7.19
10	0.30	8.35	8.35	7.19
11	0.33	8.31	8.31	7.16
12	0.36	8.31	8.31	7.16
13	0.39	8.31	8.31	7.16
14	0.43	8.31	8.31	7.16
15	0.46	8.31	8.31	7.16
16	0.49	8.31	8.31	7.16
17	0.53	8.31	8.31	7.16
18	0.56	8.31	8.31	[illegible]
19	0.59	8.31	8.31	[illegible]
20	0.62	8.31	8.31	7.16
21	0.66	8.30	8.30	7.15
22	0.69	8.30	8.30	7.15
23	0.73	8.30	8.30	7.15
24	0.76	8.30	8.30	7.15
25	0.80	8.27	8.27	7.13
26	0.84	8.27	8.27	7.13
27	0.89	8.26	8.26	7.12
28	0.94	8.26	8.26	7.12
29	0.98	8.27	8.27	7.13
30	1.04	8.26	8.26	7.12
31	1.09	8.22	8.22	7.09
32	1.15	8.24	8.24	7.11
33	1.22	8.23	8.23	7.10
34	1.28	8.23	8.23	7.10
35	1.35	8.19	8.19	7.07
36	1.43	8.18	8.18	7.06
37	1.51	8.18	8.18	7.06
38	1.59	8.17	8.17	7.06
39	1.68	8.17	8.17	7.06
40	1.77	8.17	8.17	7.06
41	1.87	8.17	8.17	7.06
42	1.98	8.17	8.17	7.06
43	2.09	8.17	8.17	7.06
44	2.21	8.13	8.13	[illegible]
45	2.33	8.13	8.13	[illegible]
46	2.46	8.13	8.13	7.03
47	2.60	8.12	8.12	7.02
48	2.75	8.09	8.09	7.00
49	2.91	8.09	8.09	7.00
50	3.08	8.08	8.08	[illegible]

CH2M-Jones	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	Date: 11/14/02	Page 3
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW006	F617GW006
Discharge 0.13 U.S.gal/min	
Static water level: 0.00 ft below datum	Pumping test duration: 349.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
51	3.25	8.04	8.04	6.96
52	3.44	8.04	8.04	6.96
53	3.64	8.09	8.09	7.00
54	3.85	8.05	8.05	6.97
55	4.07	8.05	8.05	6.97
56	4.31	8.01	8.01	6.94
57	4.56	8.00	8.00	6.93
58	4.82	8.00	8.00	6.93
59	5.10	7.96	7.96	6.90
60	5.40	7.92	7.92	6.87
61	5.71	8.13	8.13	7.03
62	6.05	8.11	8.11	7.01
63	6.40	8.10	8.10	7.01
64	6.77	8.07	8.07	6.98
65	7.17	8.03	8.03	6.96
66	7.59	8.02	8.02	6.95
67	8.03	7.98	7.98	6.92
68	8.50	7.93	7.93	6.88
69	9.00	7.89	7.89	6.85
70	9.53	7.85	7.85	6.82
71	10.09	7.81	7.81	6.79
72	10.68	7.76	7.76	6.76
73	11.31	7.72	7.72	6.73
74	11.98	7.68	7.68	6.70
75	12.68	7.63	7.63	6.66
76	13.43	7.59	7.59	6.63
77	14.22	7.54	7.54	6.59
78	15.05	7.45	7.45	6.52
79	15.94	7.40	7.40	6.49
80	16.88	7.34	7.34	6.44
81	17.87	7.29	7.29	6.40
82	18.93	7.18	7.18	6.32
83	20.04	7.12	7.12	6.28
84	21.22	7.05	7.05	6.22
85	22.48	6.98	6.98	6.17
86	23.80	6.87	6.87	6.08
87	25.21	6.80	6.80	6.03
88	26.70	6.71	6.71	5.96
89	28.27	6.63	6.63	5.90
90	29.94	6.50	6.50	5.80
91	31.71	6.41	6.41	5.73
92	33.58	6.31	6.31	5.65
93	35.57	6.20	6.20	5.56
94	37.67	6.09	6.09	5.47
95	39.90	5.96	5.96	5.37
96	42.26	5.85	5.85	5.28
97	44.76	5.70	5.70	5.16
98	47.40	5.59	5.59	5.07
99	50.21	5.43	5.43	4.94
100	53.18	5.30	5.30	[illegible]

CH2M-Jones	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	Date: 11/14/02	Page 4
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW006	F617GW006
Discharge 0.13 U.S.gal/min	
Static water level: 0.00 ft below datum	Pumping test duration: 349.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
101	56.32	5.14	5.14	4.70
102	59.65	4.98	4.98	4.57
103	63.18	4.84	4.84	4.45
104	66.92	4.69	4.69	4.32
105	70.88	4.50	4.50	4.16
106	75.08	4.33	4.33	4.02
107	79.52	4.17	4.17	3.88
108	84.23	4.01	4.01	3.74
109	89.21	3.82	3.82	3.58
110	94.21	3.66	3.66	3.44
111	99.21	3.50	3.50	3.30
112	104.21	3.33	3.33	3.15
113	109.21	3.17	3.17	3.00
114	114.21	3.02	3.02	2.87
115	119.21	2.87	2.87	2.73
116	124.21	2.71	2.71	2.59
117	129.21	2.57	2.57	2.46
118	134.21	2.42	2.42	[illegible]
119	139.21	2.27	2.27	[illegible]
120	144.21	2.13	2.13	2.05
121	149.21	2.01	2.01	1.94
122	154.21	1.89	1.89	1.83
123	159.21	1.78	1.78	1.73
124	164.21	1.68	1.68	1.63
125	169.21	1.60	1.60	1.56
126	174.21	1.51	1.51	1.47
127	179.21	1.43	1.43	1.40
128	184.21	1.35	1.35	1.32
129	189.21	1.28	1.28	1.25
130	194.21	1.22	1.22	1.20
131	199.21	1.12	1.12	1.10
132	204.21	1.02	1.02	1.00
133	209.21	0.94	0.94	0.93
134	214.21	0.86	0.86	0.85
135	219.21	0.80	0.80	0.79
136	224.21	0.74	0.74	0.73
137	229.21	0.69	0.69	0.68
138	234.21	0.65	0.65	0.64
139	239.21	0.62	0.62	0.61
140	244.21	0.58	0.58	0.57
141	249.21	0.56	0.56	0.55
142	254.21	0.53	0.53	0.53
143	259.21	0.52	0.52	0.52
144	264.21	0.50	0.50	[illegible]
145	269.21	0.48	0.48	[illegible]
146	274.21	0.47	0.47	0.47
147	279.21	0.46	0.46	0.46
148	284.21	0.45	0.45	0.45
149	289.21	0.44	0.44	0.44
150	294.21	0.43	0.43	0.43

CH2M-Jones	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	Date: 11/14/02	Page 5
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW006	F617GW006
Discharge 0.13 U.S.gal/min	
Static water level: 0.00 ft below datum	Pumping test duration: 349.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
151	299.21	0.42	0.42	0.42
152	304.21	0.42	0.42	0.42
153	309.21	0.41	0.41	0.41
154	314.21	0.41	0.41	0.41
155	319.21	0.40	0.40	0.40
156	324.21	0.39	0.39	0.39
157	329.21	0.40	0.40	0.40
158	334.21	0.39	0.39	0.39
159	339.21	0.37	0.37	0.37
160	344.21	0.36	0.36	0.36
161	349.21	0.35	0.35	0.35
162	354.21	0.34	0.34	0.34
163	359.21	0.32	0.32	0.32
164	364.21	0.32	0.32	0.32
165	369.21	0.33	0.33	0.33
166	374.21	0.33	0.33	0.33
167	379.21	0.33	0.33	0.33
168	384.21	0.34	0.34	0.34
169	389.21	0.33	0.33	0.33
170	394.21	0.32	0.32	0.32
171	399.21	0.30	0.30	0.30
172	404.21	0.28	0.28	0.28
173	409.21	0.28	0.28	0.28
174	414.21	0.28	0.28	0.28
175	419.21	0.28	0.28	0.28
176	424.21	0.28	0.28	0.28
177	429.21	0.27	0.27	0.27
178	434.21	0.26	0.26	0.26
179	439.21	0.27	0.27	0.27
180	444.21	0.25	0.25	0.25
181	449.21	0.24	0.24	0.24
182	454.21	0.25	0.25	0.25
183	459.21	0.25	0.25	0.25
184	464.21	0.24	0.24	0.24
185	469.21	0.24	0.24	0.24
186	474.21	0.23	0.23	0.23
187	479.21	0.23	0.23	0.23
188	484.21	0.23	0.23	0.23
189	489.21	0.23	0.23	0.23
190	494.21	0.23	0.23	0.23
191	499.21	0.22	0.22	0.22
192	504.21	0.25	0.25	0.25
193	509.21	0.25	0.25	0.25
194	514.21	0.25	0.25	0.25
195	519.21	0.25	0.25	0.25
196	524.21	0.24	0.24	0.24
197	529.21	0.23	0.23	0.23
198	534.21	0.22	0.22	0.22
199	539.21	0.24	0.24	0.24
200	544.21	0.23	0.23	0.23

CH2M-Jones	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	Date: 11/14/02	Page 6
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW006	F617GW006
Discharge 0.13 U.S.gal/min	
Static water level: 0.00 ft below datum	Pumping test duration: 349.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
201	549.21	0.38	0.38	0.38
202	554.21	0.38	0.38	0.38
203	559.21	0.37	0.37	0.37
204	564.21	0.36	0.36	0.36
205	569.21	0.36	0.36	0.36
206	574.21	0.34	0.34	0.34
207	579.21	0.32	0.32	0.32
208	584.21	0.32	0.32	0.32
209	589.21	0.32	0.32	0.32
210	594.21	0.30	0.30	0.30
211	599.21	0.29	0.29	0.29
212	604.21	0.29	0.29	0.29
213	609.21	0.28	0.28	0.28
214	614.21	0.28	0.28	0.28
215	619.21	0.29	0.29	0.29
216	624.21	0.29	0.29	0.29
217	629.21	0.28	0.28	0.28
218	634.21	0.29	0.29	[illegible]
219	639.21	0.27	0.27	[illegible]
220	644.21	0.26	0.26	0.26
221	649.21	0.25	0.25	0.25
222	654.21	0.24	0.24	0.24
223	659.21	0.23	0.23	0.23
224	664.21	0.23	0.23	0.23
225	669.21	0.24	0.24	0.24
226	674.21	0.24	0.24	0.24
227	679.21	0.23	0.23	0.23
228	684.21	0.23	0.23	0.23
229	689.21	0.22	0.22	0.22
230	694.21	0.24	0.24	0.24
231	699.21	0.22	0.22	0.22
232	704.21	0.21	0.21	0.21
233	709.21	0.17	0.17	0.17
234	714.21	0.15	0.15	0.15
235	719.21	0.09	0.09	0.09
236	724.21	0.10	0.10	0.10
237	729.21	0.09	0.09	0.09
238	734.21	0.08	0.08	0.08
239	739.21	0.09	0.09	0.09
240	744.21	0.09	0.09	0.09
241	749.21	0.11	0.11	0.11
242	754.21	0.10	0.10	0.10
243	759.21	0.09	0.09	0.09
244	764.21	0.09	0.09	[illegible]
245	769.21	0.09	0.09	[illegible]
246	774.21	0.09	0.09	0.09
247	779.21	0.07	0.07	0.07
248	784.21	0.08	0.08	0.08
249	789.21	0.09	0.09	0.09
250	794.21	0.09	0.09	0.09

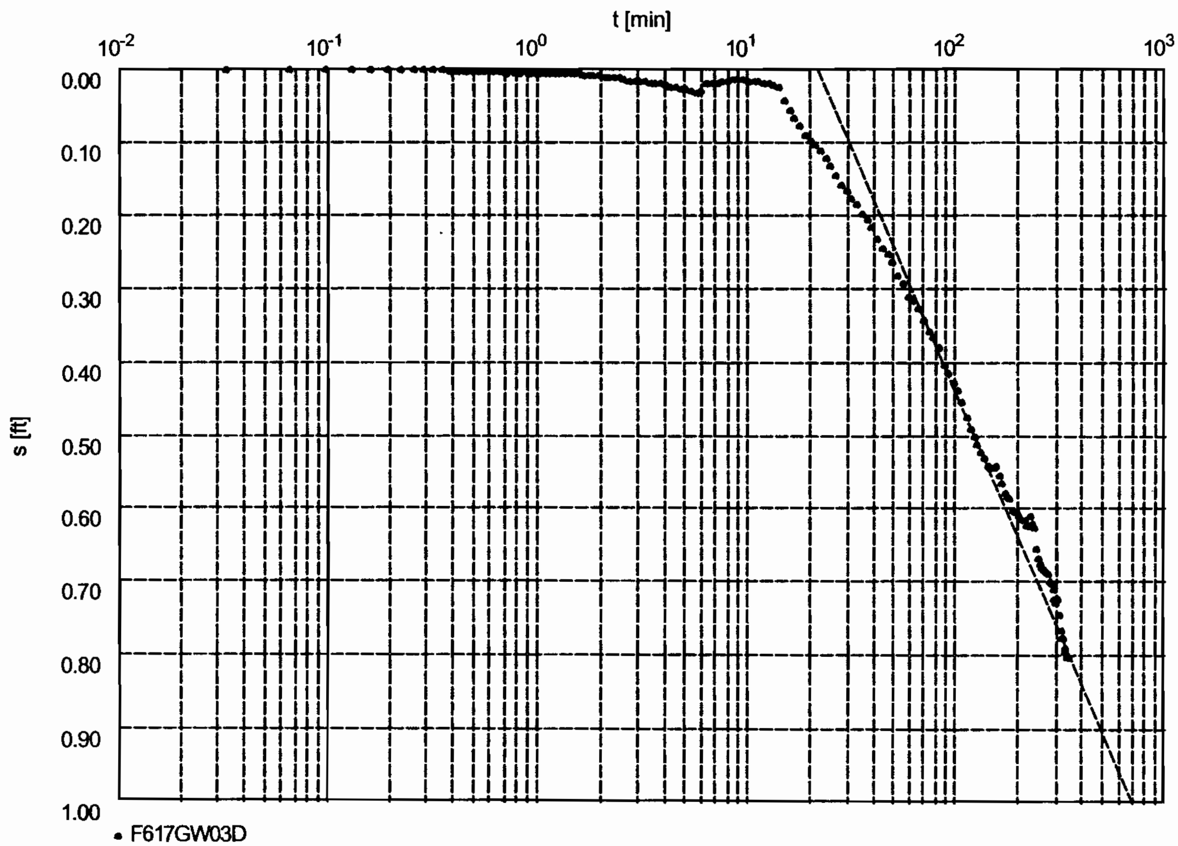
CH2M-Jones	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	Date: 11/14/02	Page 7
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW006	F617GW006
Discharge 0.13 U.S.gal/min	
Static water level: 0.00 ft below datum	Pumping test duration: 349.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
251	799.21	0.08	0.08	0.08
252	804.21	0.07	0.07	0.07
253	809.21	0.06	0.06	0.06
254	814.21	0.05	0.05	0.05
255	819.21	0.07	0.07	0.07
256	824.21	0.09	0.09	0.09
257	829.21	0.09	0.09	0.09

CH2M-Jones	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	Date: 11/14/02	Page 1
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW03D	
Discharge 0.13 U.S.gal/min	



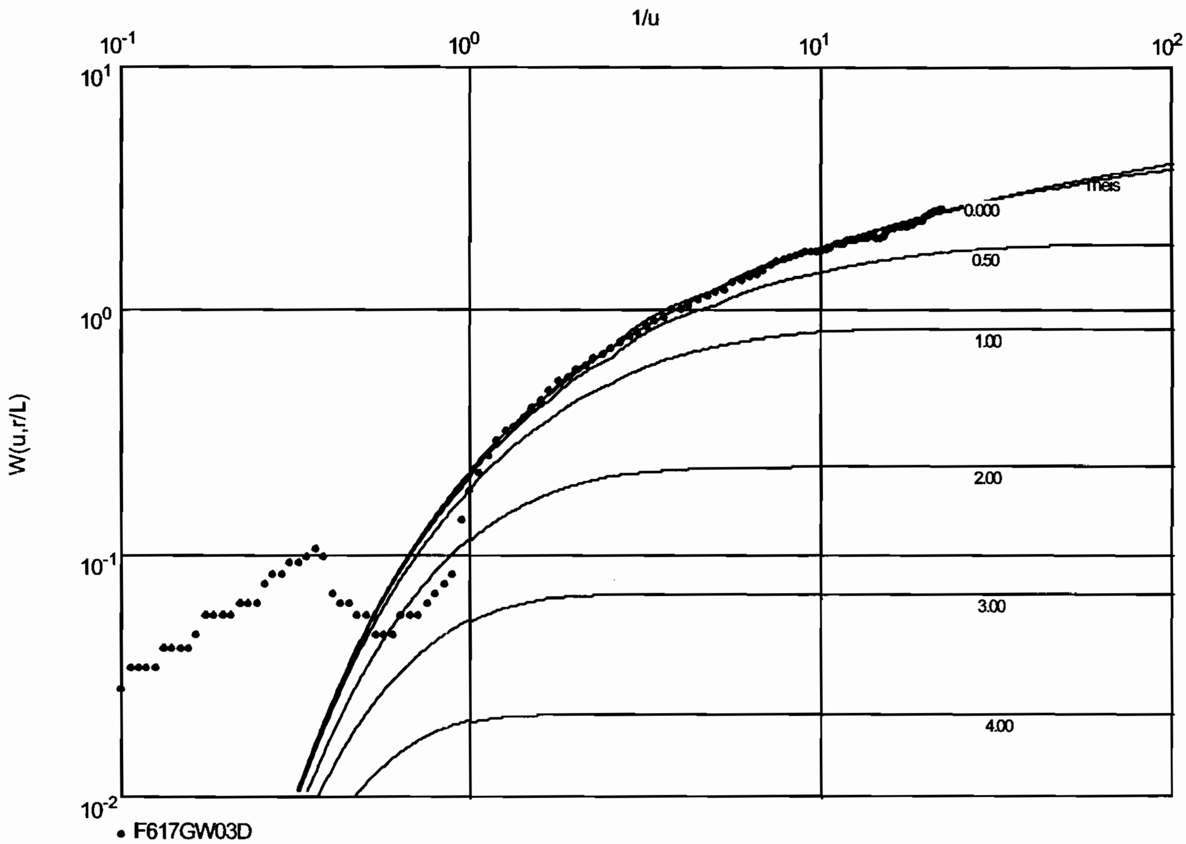
Transmissivity [ft²/min]: 4.81×10^{-3}

Hydraulic conductivity [ft/min]: 1.60×10^{-4}

Aquifer thickness [ft]: 30.00

CH2M-Jones	Pumping test analysis HANTUSH's method Leaky aquifer, no aquitard storage	Date: 11/14/02	Page 1
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW03D	
Discharge 0.13 U.S.gal/min	



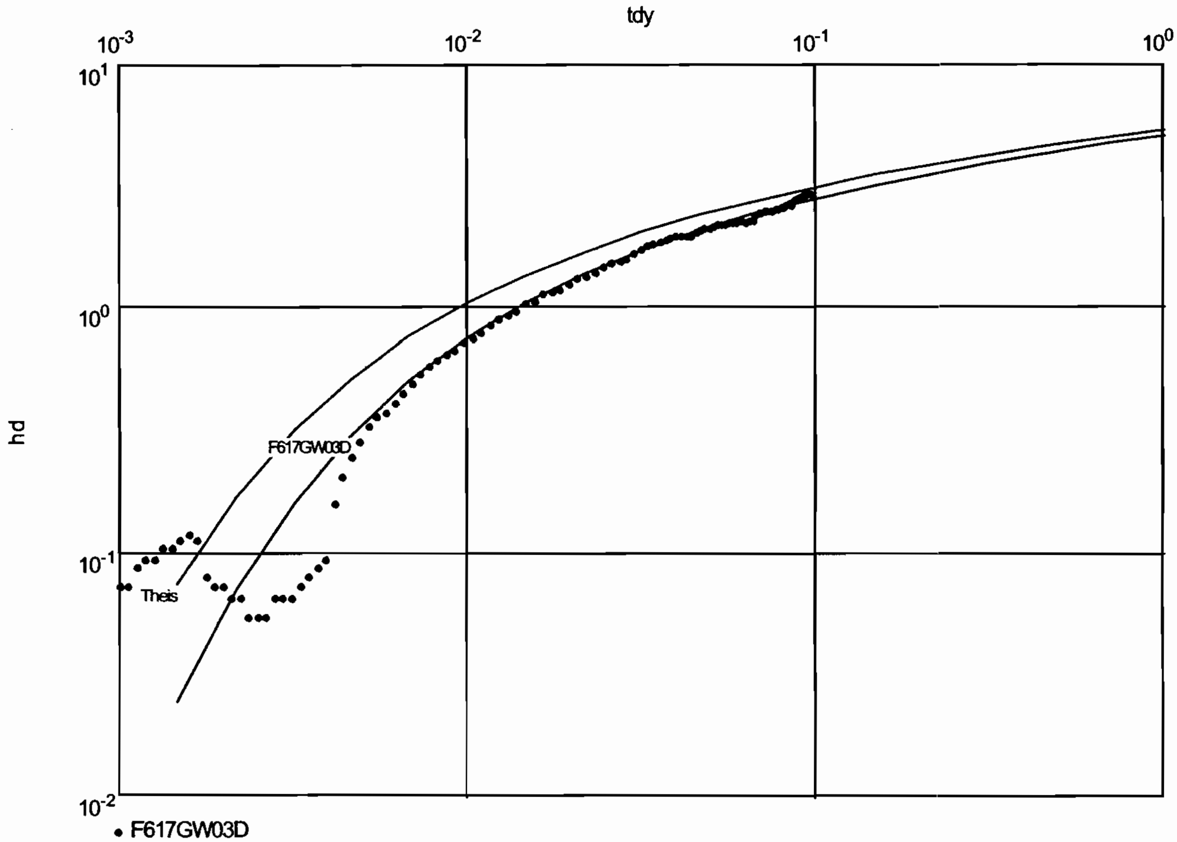
Transmissivity [ft²/min]: 4.37×10^{-3}

Hydraulic conductivity [ft/min]: 1.45×10^{-4}

Aquifer thickness [ft]: 30.00

CH2M-Jones	Pumping test analysis MOENCH's method Confined aquifer	Date: 11/14/02	Page 1
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW03D	
Discharge 0.13 U.S.gal/min	



Transmissivity [ft²/min]: 4.90×10^{-3}

Hydraulic conductivity [ft/min]: 1.63×10^{-4}

Aquifer thickness [ft]: 30.00

Storativity: 1.09×10^{-4}

Hydraulic conductivity vertical [ft/min]: 1.63×10^{-5}

CH2M-Jones	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	Date: 11/14/02	Page 2
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW03D	F617GW03D
Discharge 0.13 U.S.gal/min	Distance from the pumping well 40.10 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
2	0.03	0.00	0.00	0.00
3	0.07	0.00	0.00	0.00
4	0.10	0.00	0.00	0.00
5	0.13	0.00	0.00	0.00
6	0.16	0.00	0.00	0.00
7	0.20	0.00	0.00	0.00
8	0.23	0.00	0.00	0.00
9	0.26	0.00	0.00	0.00
10	0.30	0.00	0.00	0.00
11	0.33	0.00	0.00	0.00
12	0.36	0.00	0.00	0.00
13	0.39	0.00	0.00	0.00
14	0.43	0.00	0.00	0.00
15	0.46	0.00	0.00	0.00
16	0.49	0.00	0.00	0.00
17	0.53	0.00	0.00	0.00
18	0.56	0.00	0.00	0.0
19	0.59	0.00	0.00	0.0
20	0.62	0.00	0.00	0.00
21	0.66	0.00	0.00	0.00
22	0.69	0.00	0.00	0.00
23	0.73	0.01	0.01	0.01
24	0.76	0.00	0.00	0.00
25	0.80	0.01	0.01	0.01
26	0.84	0.01	0.01	0.01
27	0.89	0.00	0.00	0.00
28	0.94	0.01	0.01	0.01
29	0.98	0.01	0.01	0.01
30	1.04	0.01	0.01	0.01
31	1.09	0.01	0.01	0.01
32	1.15	0.01	0.01	0.01
33	1.22	0.01	0.01	0.01
34	1.28	0.01	0.01	0.01
35	1.35	0.01	0.01	0.01
36	1.43	0.01	0.01	0.01
37	1.51	0.01	0.01	0.01
38	1.59	0.01	0.01	0.01
39	1.68	0.01	0.01	0.01
40	1.77	0.01	0.01	0.01
41	1.87	0.01	0.01	0.01
42	1.98	0.01	0.01	0.01
43	2.09	0.01	0.01	0.01
44	2.21	0.01	0.01	0.01
45	2.33	0.01	0.01	0.0
46	2.46	0.01	0.01	0.0
47	2.60	0.02	0.02	0.01
48	2.75	0.02	0.02	0.02
49	2.91	0.02	0.02	0.02
50	3.08	0.02	0.02	0.02

CH2M-Jones	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	Date: 11/14/02	Page 3
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW03D	F617GW03D
Discharge 0.13 U.S.gal/min	Distance from the pumping well 40.10 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
51	3.25	0.02	0.02	0.02
52	3.44	0.02	0.02	0.02
53	3.64	0.02	0.02	0.02
54	3.85	0.02	0.02	0.02
55	4.07	0.02	0.02	0.02
56	4.31	0.03	0.03	0.03
57	4.56	0.03	0.03	0.03
58	4.82	0.03	0.03	0.03
59	5.10	0.03	0.03	0.03
60	5.40	0.03	0.03	0.03
61	5.71	0.03	0.03	0.03
62	6.05	0.03	0.03	0.03
63	6.40	0.02	0.02	0.02
64	6.77	0.02	0.02	0.02
65	7.17	0.02	0.02	0.02
66	7.59	0.02	0.02	0.02
67	8.03	0.02	0.02	0.02
68	8.50	0.02	0.02	0.01
69	9.00	0.02	0.02	0.01
70	9.53	0.02	0.02	0.01
71	10.09	0.02	0.02	0.02
72	10.68	0.02	0.02	0.02
73	11.31	0.02	0.02	0.02
74	11.98	0.02	0.02	0.02
75	12.68	0.02	0.02	0.02
76	13.43	0.02	0.02	0.02
77	14.22	0.03	0.03	0.03
78	15.05	0.04	0.04	0.04
79	15.94	0.06	0.06	0.06
80	16.88	0.07	0.07	0.07
81	17.87	0.08	0.08	0.08
82	18.93	0.09	0.09	0.09
83	20.04	0.10	0.10	0.10
84	21.22	0.11	0.11	0.10
85	22.48	0.11	0.11	0.11
86	23.80	0.13	0.13	0.12
87	25.21	0.14	0.14	0.14
88	26.70	0.15	0.15	0.15
89	28.27	0.16	0.16	0.16
90	29.94	0.17	0.17	0.17
91	31.71	0.18	0.18	0.18
92	33.58	0.19	0.19	0.19
93	35.57	0.20	0.20	0.20
94	37.67	0.21	0.21	0.21
95	39.90	0.22	0.22	0.22
96	42.26	0.23	0.23	0.23
97	44.76	0.25	0.25	0.25
98	47.40	0.26	0.26	0.26
99	50.21	0.27	0.27	0.27
100	53.18	0.29	0.29	0.29

CH2M-Jones	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	Date: 11/14/02	Page 4
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW03D	F617GW03D
Discharge 0.13 U.S.gal/min	Distance from the pumping well 40.10 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
101	56.32	0.30	0.30	0.29
102	59.65	0.32	0.32	0.31
103	63.18	0.32	0.32	0.32
104	66.92	0.33	0.33	0.33
105	70.88	0.35	0.35	0.34
106	75.08	0.36	0.36	0.36
107	79.52	0.37	0.37	0.37
108	84.23	0.38	0.38	0.38
109	89.21	0.41	0.41	0.41
110	94.21	0.42	0.42	0.42
111	99.21	0.43	0.43	0.43
112	104.21	0.44	0.44	0.44
113	109.21	0.46	0.46	0.46
114	114.21	0.48	0.48	0.48
115	119.21	0.50	0.50	0.49
116	124.21	0.51	0.51	0.50
117	129.21	0.52	0.52	0.51
118	134.21	0.53	0.53	0.52
119	139.21	0.54	0.54	0.5[illegible]
120	144.21	0.55	0.55	0.54
121	149.21	0.55	0.55	0.55
122	154.21	0.55	0.55	0.55
123	159.21	0.55	0.55	0.54
124	164.21	0.56	0.56	0.56
125	169.21	0.57	0.57	0.57
126	174.21	0.59	0.59	0.58
127	179.21	0.59	0.59	0.59
128	184.21	0.60	0.60	0.59
129	189.21	0.61	0.61	0.60
130	194.21	0.61	0.61	0.61
131	199.21	0.61	0.61	0.61
132	204.21	0.62	0.62	0.61
133	209.21	0.62	0.62	0.62
134	214.21	0.63	0.63	0.62
135	219.21	0.63	0.63	0.63
136	224.21	0.63	0.63	0.63
137	229.21	0.62	0.62	0.61
138	234.21	0.63	0.63	0.62
139	239.21	0.64	0.64	0.63
140	244.21	0.66	0.66	0.66
141	249.21	0.68	0.68	0.67
142	254.21	0.69	0.69	0.68
143	259.21	0.69	0.69	0.68
144	264.21	0.69	0.69	0.68
145	269.21	0.69	0.69	0.6[illegible]
146	274.21	0.70	0.70	0.6[illegible]
147	279.21	0.70	0.70	0.69
148	284.21	0.71	0.71	0.70
149	289.21	0.71	0.71	0.70
150	294.21	0.72	0.72	0.71

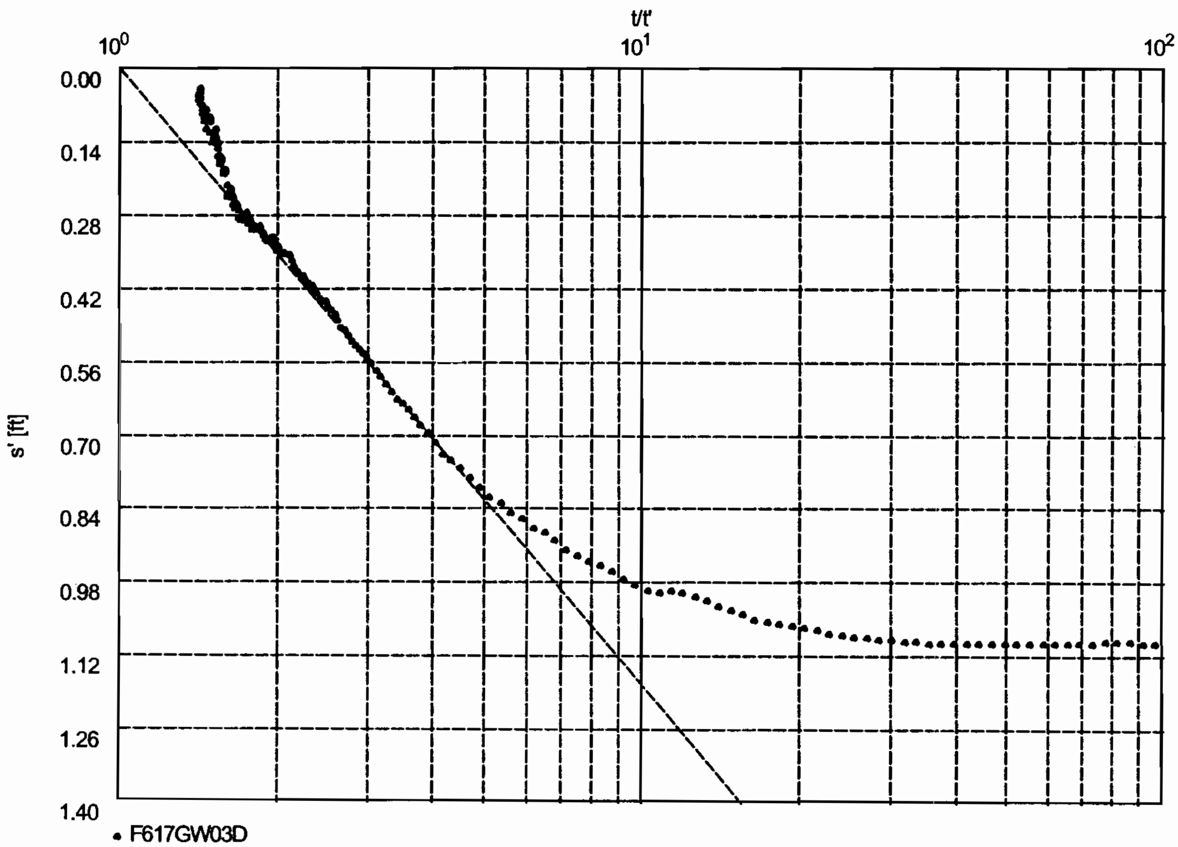
CH2M-Jones	Pumping test analysis Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	Date: 11/14/02	Page 5
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW03D	F617GW03D
Discharge 0.13 U.S.gal/min	Distance from the pumping well 40.10 ft
Static water level: 0.00 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
151	299.21	0.73	0.73	0.73
152	304.21	0.74	0.74	0.73
153	309.21	0.73	0.73	0.73
154	314.21	0.76	0.76	0.75
155	319.21	0.78	0.78	0.77
156	324.21	0.79	0.79	0.78
157	329.21	0.79	0.79	0.78
158	334.21	0.80	0.80	0.79
159	339.21	0.81	0.81	0.80
160	344.21	0.82	0.82	0.80
161	349.21	0.82	0.82	0.80

CH2M-Jones	Pumping test analysis Recovery method after THEIS & JACOB Confined aquifer	Date: 11/14/02	Page 1
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW03D	
Discharge 0.13 U.S.gal/min	
	Pumping test duration: 349.00 min



Transmissivity [ft²/min]: 2.71×10^{-3}

Hydraulic conductivity [ft/min]: 9.04×10^{-5}

Aquifer thickness [ft]: 30.00

CH2M-Jones	Pumping test analysis Recovery method after THEIS & JACOB Confined aquifer	Date: 11/14/02	Page 2
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW03D	F617GW03D
Discharge 0.13 U.S.gal/min	Distance from the pumping well 40.10 ft
Static water level: 0.00 ft below datum	Pumping test duration: 349.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	
2	0.03	1.10	1.10	
3	0.07	1.10	1.10	
4	0.10	1.10	1.10	
5	0.13	1.10	1.10	
6	0.16	1.10	1.10	
7	0.20	1.10	1.10	
8	0.23	1.10	1.10	
9	0.26	1.10	1.10	
10	0.30	1.10	1.10	
11	0.33	1.10	1.10	
12	0.36	1.10	1.10	
13	0.39	1.10	1.10	
14	0.43	1.10	1.10	
15	0.46	1.10	1.10	
16	0.49	1.10	1.10	
17	0.53	1.10	1.10	
18	0.56	1.10	1.10	
19	0.59	1.10	1.10	
20	0.62	1.10	1.10	
21	0.66	1.10	1.10	
22	0.69	1.10	1.10	
23	0.73	1.10	1.10	
24	0.76	1.10	1.10	
25	0.80	1.10	1.10	
26	0.84	1.10	1.10	
27	0.89	1.10	1.10	
28	0.94	1.10	1.10	
29	0.98	1.10	1.10	
30	1.04	1.10	1.10	
31	1.09	1.10	1.10	
32	1.15	1.10	1.10	
33	1.22	1.10	1.10	
34	1.28	1.10	1.10	
35	1.35	1.10	1.10	
36	1.43	1.10	1.10	
37	1.51	1.10	1.10	
38	1.59	1.10	1.10	
39	1.68	1.10	1.10	
40	1.77	1.10	1.10	
41	1.87	1.10	1.10	
42	1.98	1.10	1.10	
43	2.09	1.10	1.10	
44	2.21	1.10	1.10	
45	2.33	1.10	1.10	
46	2.46	1.10	1.10	
47	2.60	1.10	1.10	
48	2.75	1.10	1.10	
49	2.91	1.10	1.10	
50	3.08	1.10	1.10	

CH2M-Jones	Pumping test analysis Recovery method after THEIS & JACOB Confined aquifer	Date: 11/14/02	Page 3
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW03D	F617GW03D
Discharge 0.13 U.S.gal/min	Distance from the pumping well 40.10 ft
Static water level: 0.00 ft below datum	Pumping test duration: 349.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	
51	3.25	1.10	1.10	
52	3.44	1.10	1.10	
53	3.64	1.10	1.10	
54	3.85	1.10	1.10	
55	4.07	1.09	1.09	
56	4.31	1.09	1.09	
57	4.56	1.09	1.09	
58	4.82	1.10	1.10	
59	5.10	1.10	1.10	
60	5.40	1.10	1.10	
61	5.71	1.10	1.10	
62	6.05	1.10	1.10	
63	6.40	1.10	1.10	
64	6.77	1.10	1.10	
65	7.17	1.10	1.10	
66	7.59	1.10	1.10	
67	8.03	1.10	1.10	
68	8.50	1.10	1.10	
69	9.00	1.10	1.10	
70	9.53	1.10	1.10	
71	10.09	1.10	1.10	
72	10.68	1.09	1.09	
73	11.31	1.09	1.09	
74	11.98	1.09	1.09	
75	12.68	1.09	1.09	
76	13.43	1.09	1.09	
77	14.22	1.08	1.08	
78	15.05	1.08	1.08	
79	15.94	1.08	1.08	
80	16.88	1.07	1.07	
81	17.87	1.07	1.07	
82	18.93	1.07	1.07	
83	20.04	1.06	1.06	
84	21.22	1.06	1.06	
85	22.48	1.05	1.05	
86	23.80	1.04	1.04	
87	25.21	1.03	1.03	
88	26.70	1.03	1.03	
89	28.27	1.02	1.02	
90	29.94	1.01	1.01	
91	31.71	1.00	1.00	
92	33.58	1.00	1.00	
93	35.57	1.00	1.00	
94	37.67	1.00	1.00	
95	39.90	0.99	0.99	
96	42.26	0.98	0.98	
97	44.76	0.96	0.96	
98	47.40	0.95	0.95	
99	50.21	0.94	0.94	
100	53.18	0.93	0.93	

CH2M-Jones	Pumping test analysis Recovery method after THEIS & JACOB Confined aquifer	Date: 11/14/02	Page 4
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW03D	F617GW03D
Discharge 0.13 U.S.gal/min	Distance from the pumping well 40.10 ft
Static water level: 0.00 ft below datum	Pumping test duration: 349.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	
101	56.32	0.92	0.92	
102	59.65	0.90	0.90	
103	63.18	0.89	0.89	
104	66.92	0.88	0.88	
105	70.88	0.86	0.86	
106	75.08	0.85	0.85	
107	79.52	0.83	0.83	
108	84.23	0.82	0.82	
109	89.21	0.80	0.80	
110	94.21	0.78	0.78	
111	99.21	0.77	0.77	
112	104.21	0.75	0.75	
113	109.21	0.74	0.74	
114	114.21	0.72	0.72	
115	119.21	0.70	0.70	
116	124.21	0.69	0.69	
117	129.21	0.67	0.67	
118	134.21	0.65	0.65	
119	139.21	0.64	0.64	
120	144.21	0.64	0.64	
121	149.21	0.62	0.62	
122	154.21	0.61	0.61	
123	159.21	0.59	0.59	
124	164.21	0.58	0.58	
125	169.21	0.57	0.57	
126	174.21	0.56	0.56	
127	179.21	0.55	0.55	
128	184.21	0.54	0.54	
129	189.21	0.53	0.53	
130	194.21	0.52	0.52	
131	199.21	0.51	0.51	
132	204.21	0.50	0.50	
133	209.21	0.50	0.50	
134	214.21	0.48	0.48	
135	219.21	0.47	0.47	
136	224.21	0.47	0.47	
137	229.21	0.46	0.46	
138	234.21	0.45	0.45	
139	239.21	0.45	0.45	
140	244.21	0.44	0.44	
141	249.21	0.43	0.43	
142	254.21	0.43	0.43	
143	259.21	0.42	0.42	
144	264.21	0.41	0.41	
145	269.21	0.41	0.41	
146	274.21	0.41	0.41	
147	279.21	0.40	0.40	
148	284.21	0.40	0.40	
149	289.21	0.39	0.39	
150	294.21	0.39	0.39	

CH2M-Jones	Pumping test analysis Recovery method after THEIS & JACOB Confined aquifer	Date: 11/14/02	Page 5
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW03D	F617GW03D
Discharge 0.13 U.S.gal/min	Distance from the pumping well 40.10 ft
Static water level: 0.00 ft below datum	Pumping test duration: 349.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	
151	299.21	0.38	0.38	
152	304.21	0.37	0.37	
153	309.21	0.36	0.36	
154	314.21	0.36	0.36	
155	319.21	0.36	0.36	
156	324.21	0.36	0.36	
157	329.21	0.35	0.35	
158	334.21	0.35	0.35	
159	339.21	0.34	0.34	
160	344.21	0.34	0.34	
161	349.21	0.35	0.35	
162	354.21	0.34	0.34	
163	359.21	0.32	0.32	
164	364.21	0.32	0.32	
165	369.21	0.33	0.33	
166	374.21	0.33	0.33	
167	379.21	0.33	0.33	
168	384.21	0.33	0.33	
169	389.21	0.32	0.32	
170	394.21	0.32	0.32	
171	399.21	0.31	0.31	
172	404.21	0.30	0.30	
173	409.21	0.31	0.31	
174	414.21	0.31	0.31	
175	419.21	0.31	0.31	
176	424.21	0.31	0.31	
177	429.21	0.30	0.30	
178	434.21	0.30	0.30	
179	439.21	0.31	0.31	
180	444.21	0.30	0.30	
181	449.21	0.29	0.29	
182	454.21	0.30	0.30	
183	459.21	0.29	0.29	
184	464.21	0.28	0.28	
185	469.21	0.28	0.28	
186	474.21	0.28	0.28	
187	479.21	0.28	0.28	
188	484.21	0.29	0.29	
189	489.21	0.29	0.29	
190	494.21	0.29	0.29	
191	499.21	0.29	0.29	
192	504.21	0.28	0.28	
193	509.21	0.27	0.27	
194	514.21	0.26	0.26	
195	519.21	0.27	0.27	
196	524.21	0.26	0.26	
197	529.21	0.26	0.26	
198	534.21	0.25	0.25	
199	539.21	0.25	0.25	
200	544.21	0.24	0.24	

CH2M-Jones	Pumping test analysis Recovery method after THEIS & JACOB Confined aquifer	Date: 11/14/02	Page 6
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW03D	F617GW03D
Discharge 0.13 U.S.gal/min	Distance from the pumping well 40.10 ft
Static water level: 0.00 ft below datum	Pumping test duration: 349.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	
201	549.21	0.23	0.23	
202	554.21	0.24	0.24	
203	559.21	0.24	0.24	
204	564.21	0.25	0.25	
205	569.21	0.24	0.24	
206	574.21	0.23	0.23	
207	579.21	0.20	0.20	
208	584.21	0.20	0.20	
209	589.21	0.20	0.20	
210	594.21	0.20	0.20	
211	599.21	0.19	0.19	
212	604.21	0.18	0.18	
213	609.21	0.17	0.17	
214	614.21	0.17	0.17	
215	619.21	0.18	0.18	
216	624.21	0.18	0.18	
217	629.21	0.17	0.17	
218	634.21	0.17	0.17	
219	639.21	0.15	0.15	
220	644.21	0.14	0.14	
221	649.21	0.14	0.14	
222	654.21	0.13	0.13	
223	659.21	0.12	0.12	
224	664.21	0.12	0.12	
225	669.21	0.13	0.13	
226	674.21	0.13	0.13	
227	679.21	0.13	0.13	
228	684.21	0.12	0.12	
229	689.21	0.13	0.13	
230	694.21	0.14	0.14	
231	699.21	0.12	0.12	
232	704.21	0.10	0.10	
233	709.21	0.10	0.10	
234	714.21	0.10	0.10	
235	719.21	0.10	0.10	
236	724.21	0.10	0.10	
237	729.21	0.10	0.10	
238	734.21	0.08	0.08	
239	739.21	0.10	0.10	
240	744.21	0.10	0.10	
241	749.21	0.12	0.12	
242	754.21	0.10	0.10	
243	759.21	0.09	0.09	
244	764.21	0.10	0.10	
245	769.21	0.10	0.10	
246	774.21	0.09	0.09	
247	779.21	0.07	0.07	
248	784.21	0.08	0.08	
249	789.21	0.08	0.08	
250	794.21	0.07	0.07	

CH2M-Jones	Pumping test analysis Recovery method after THEIS & JACOB Confined aquifer	Date: 11/14/02	Page 7
		Project: AOC 617, Zone F, CNC	
		Evaluated by: Kim-Lee Murphy	

Pumping Test No. 6-HR Pump Test	Test conducted on: 11/12/02
F617GW03D	F617GW03D
Discharge 0.13 U.S.gal/min	Distance from the pumping well 40.10 ft
Static water level: 0.00 ft below datum	Pumping test duration: 349.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	
251	799.21	0.06	0.06	
252	804.21	0.04	0.04	
253	809.21	0.05	0.05	
254	814.21	0.04	0.04	
255	819.21	0.05	0.05	
256	824.21	0.06	0.06	
257	829.21	0.06	0.06	

Attachment B: Soil Boring and Well Construction Logs

PROJECT NUMBER 158814.ZF	SOIL BORING NUMBER F617GW03D	page 1 of 1

CH2MHILL

SOIL BORING LOG

PROJECT : Charleston Naval Complex (AOC 617) **LOCATION :** Charleston, SC **NORTHING:** 373409.73

ELEVATION : not measured **DRILLING CONTRACTOR :** Prosonic License # 1435 **EASTING:** 2319692.28

DRILLING METHOD AND EQUIPMENT USED : Hand auger from 0 to 5 feet and rotosonic from 5 to 30 feet

START : 10/28/2002 **END:** 10/28/2002 **LOGGER :** Mike Karafa/ATL

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS TESTS, INSTRUMENTATION ABANDONMENT METHOD
		surface: asphalt	
5	1-10'	**CLAY**: grey, sandy, medium to fine grain, stiff, saturated	split spoon
10			
	10-15'	**SAND**: some clay, tan medium grain to sandy clay, fine grain, stiff, wet	split spoon
15			
	15-20'	**CLAY**: sandy, tan fine grain, stiff, wet	split spoon
20			
	20-24'	**CLAY**: sandy, tan fine grain, stiff, wet, very little recovery (less than 1')	split spoon
25	24-26'	**CLAY**: sandy, coarse to fine grain, loose, some gravel, massive wet, grey	split spoon
	26-28'	**CLAY**: sandy, fine grain, stiff, saturated	split spoon
	28-30'	**CLAY**: sandy, fine grain, stiff, shell fragments, more abundant, saturated, tan, stiff, clay with some sand at 30'	split spoon
30			Boring ended at 30'

CH2MHILL

PROJECT NUMBER	SOIL BORING NUMBER	
158814.ZF	F617GW007	page 1 of 1

SOIL BORING LOG

PROJECT : Charleston Naval Complex (AOC 617) **LOCATION :** Charleston, SC **NORTHING:** 373370.11

ELEVATION : not measured **DRILLING CONTRACTOR :** Prosonic License # 1435 **EASTING:** 2319649.13

DRILLING METHOD AND EQUIPMENT USED : Rotosonic

START : 10/30/2002 **END:** 10/30/2002 **LOGGER :** M. Karafa/ATL

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS TESTS, INSTRUMENTATION ABANDONMENT METHOD
		surface: gravel Fill sand gravel (0-1')	
	1-5'	**SAND**: light tan, fine grain, rounded, well sorted, dry	acetate sleave
5	5-7'	**SAND**: grey, fine, grain, well sorted, rounded, dry (5-5.5') **CLAY**: sandy, dark grey, stiff, saturated, shell fragments (5.5-7')	split spoon
	7-9'	**CLAY**: sandy, medium to fine grain, poorly sorted septangular to rounded, stiff, damp, no recovery	split spoon
	9-10'	**SAND**: grey, fine grain, well sorted, loose, dry	acetate sleave
10	10-15'	**CLAY**: sandy, fine grain, well sorted, stiff, saturated at 10' bgs, orange and grey	acetate sleave
15	15-17'	**CLAY**: sandy, fine grain, well sorted, stiff, orange and grey	acetate sleave Boring ended at 17'
20			
25			
30			

PROJECT NUMBER	SOIL BORING NUMBER	
158814.ZF	F617GW006	page 1 of 1

CH2MHILL

SOIL BORING LOG

PROJECT : Charleston Naval Complex (AOC 617)	**LOCATION :** Charleston, SC			**NORTHING:**	373398.02
ELEVATION : not measured	**DRILLING CONTRACTOR :** Prosonic	License #	1435	**EASTING:**	2319680.33
DRILLING METHOD AND EQUIPMENT USED :	Rotosonic				
START : 10/30/2002	**END:** 10/30/2002	**LOGGER :**	M. Karafa/ATL		

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS TESTS, INSTRUMENTATION ABANDONMENT METHOD
		surface: Fill gravel Fill gravel (0-1')	
	1-5'	**SAND**: light tan, fine grain, well sorted, dry	acetate sleave
5			
	5-7'	**CLAY**: sandy, fine grain, stiff, grey and orange, damp	acetate sleave
	7-9'	**CLAY**: sandy, fine grain, red and light grey, stiff, damp (7-8') **CLAY**: sandy, fine to coarse grain, shell fragments, saturated (8-9')	acetate sleave
10	9-12'	**CLAY**: sandy, fine grain, well sorted, stiff, red and grey	acetate sleave
15	12-17'7"	**CLAY**: sandy, fine grain, well sorted, stiff, red and grey	acetate sleave Boring ended at 17'-7"
20			
25			
30			

CH2MHILL

PROJECT NUMBER	SOIL BORING NUMBER	
158814.ZF	F617GW008	page 1 of 1

SOIL BORING LOG

PROJECT : Charleston Naval Complex (AOC 617) **LOCATION :** Charleston, SC **NORTHING:** 373362.13

ELEVATION : not measured **DRILLING CONTRACTOR :** Prosonic License # 1435 **EASTING:** 2319706.22

DRILLING METHOD AND EQUIPMENT USED : Hand auger from 0 to 2.5 feet and rotosonic from 2.5 to 17 feet

START : 10/30/2002 **END:** 10/30/2002 **LOGGER :** M. Karafa/ATL

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS TESTS, INSTRUMENTATION ABANDONMENT METHOD
		surface: gravel	
5	0-7'	No samples due to concrete and gravel	
	7-8'	**SAND**: tan to grey, fine grain, well sorted, damp, loose	acetate sleave
	8-9'	**CLAY**: sandy, fine grain, grey and orange, stiff, damp	acetate sleave
10	9-12'	**CLAY**: sandy, fine grain,stiff, tan and orange, wet	acetate sleave
15	12-17'	**CLAY**: sandy, fine grain,stiff, tan and orange, wet	acetate sleave Boring ended at 17'
20			
25			
30			

CH2MHILL

PROJECT NUMBER	SOIL BORING NUMBER	
158814.ZF	F617GW07D	page 1 of 1

SOIL BORING LOG

PROJECT : Charleston Naval Complex (AOC 617) **LOCATION :** Charleston, SC **NORTHING:** 373368.86

ELEVATION : not measured **DRILLING CONTRACTOR :** Prosonic License # 1435 **EASTING:** 2319652.72

DRILLING METHOD AND EQUIPMENT USED : Hand auger from 0 to 1 foot and rotosonic from 1 to 30 feet

START : 10/31/2002 **END:** 10/31/2002 **LOGGER :** M. Karafa/ATL

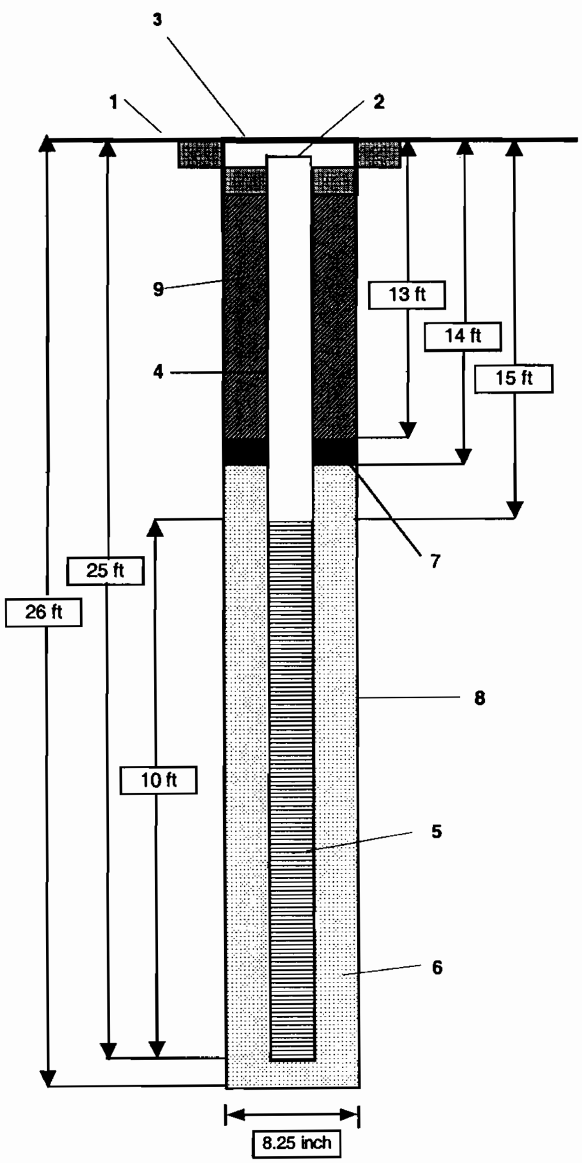
DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS TESTS, INSTRUMENTATION ABANDONMENT METHOD
	0-2'	surface: coarse gravel **GRAVEL**: coarse	
5	2-6'	**SAND**: tan, fine grain, well sorted, loose, dry	acetate sleave
	6-9'	**SAND**: dark grey, well sorted, loose, damp saturated at 9'	acetate sleave
10	9-10'	**SAND**: grey, fine grain, well sorted, loose, saturated	acetate sleave
	10-13'	**CLAY**: sandy, fine grain, well sorted, loose, saturated	acetate sleave
15	13-17'	**CLAY**: sandy, fine grain, well sorted, loose, saturated more clay content at 17'	acetate sleave
20	17-21'	**CLAY**: sandy, fine grain, well sorted, stiff, wet, grey and red mottled	acetate sleave
	21-22'	**CLAY**: sandy, some silt, wet, stiff, grey	acetate sleave
25	22-25'	**SAND**: some clay, fine to medium grain, poorly sorted, grey, saturated shell fragments increasing from 22 to 25'	acetate sleave
	25-26'	**SAND**: some clay, grey, fine to medium grain, shell fragments, saturated	acetate sleave
	26-27'	**CLAY**: sandy, massive, grey, tan, orange mottled, fine grain, wet	
30	27-30'	**SAND**: clayey, grey, fine, grain, stiff, saturated	acetate sleave Boring ended at 30'

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
158814.ZF	F617GW03D	SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : AOC 617, Zone F, Charleston Naval Complex — LOCATION : Charleston, South Carolina
DRILLING CONTRACTOR : Prosonic Corporation License # 1435 — NORTHING 373409.73
DRILLING METHOD AND EQUIPMENT USED : Prosonic (8.25-inch diameter) — EASTING: 2319692.28
WATER LEVELS : not measured — START : 10/28/2002 — END: 10/28/2002 — LOGGER : M. Karafa/ATL



1- Ground elevation at well	not measured
2- Top of casing elevation	10.03
3- Protective cover type	flush steel vault
a) concrete pad dimensions	48x48 inches
4- Dia./type of well casing	4-inch inside diameter schedule 40 PVC
5- Type/slot size of screen	0.010-inch dia. machine slotted PVC
6- Type filter pack	20/30 Sieve Size Silica Sand (5 bags)
7- Type of seal	3/4-inch bentonite Pellets 3/4 bags
8- Borehole diameter	8.25"
9- Grout	Type I Portland Cement

Note: Diagram not to scale.

PROJECT NUMBER	WELL NUMBER	
158814.ZF	F617GW007	SHEET 1 OF 1

CH2MHILL

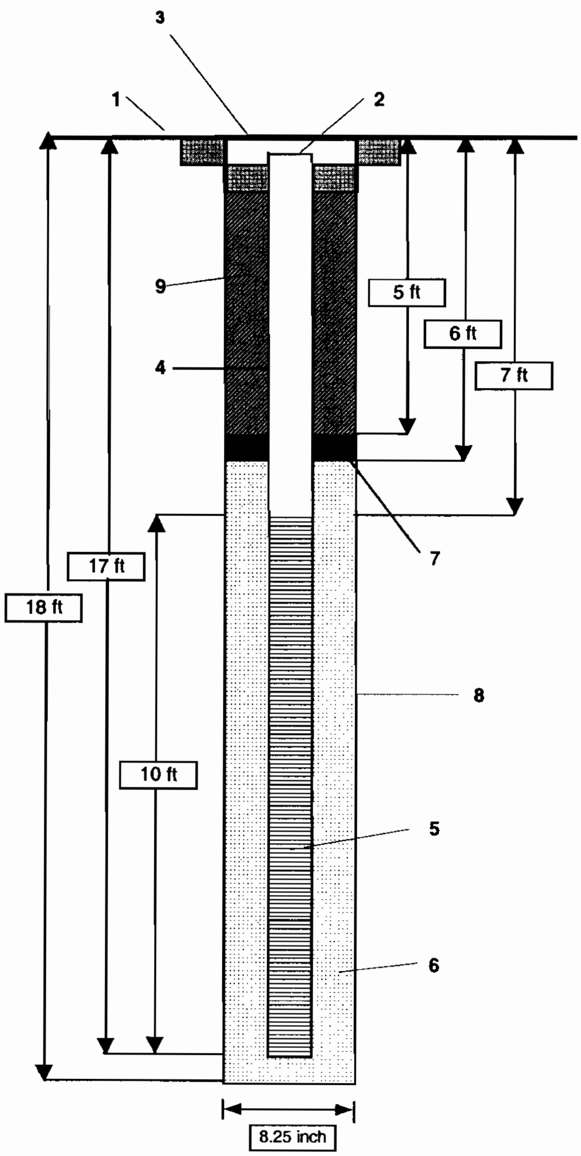
WELL COMPLETION DIAGRAM

PROJECT : AOC 617, Zone F, Charleston Naval Complex — LOCATION : Charleston, South Carolina

DRILLING CONTRACTOR : Prosonic Corporation License # 1435 — NORTHING 373370.11

DRILLING METHOD AND EQUIPMENT USED : Prosonic (8.25-inch diameter) — EASTING: 2319649.13

WATER LEVELS : not measured — START : 10/30/2002 — END: 10/30/2002 — LOGGER : M. Karafa/ATL



1- Ground elevation at well	not measured
2- Top of casing elevation	11.56
3- Protective cover type	flush steel vault
a) concrete pad dimensions	48x48 inches
4- Dia./type of well casing	4-inch inside diameter schedule 40 PVC
5- Type/slot size of screen	0.010-inch dia. machine slotted PVC
6- Type filter pack	#2 sandpack 8 bags
7- Type of seal	3/4-inch bentonite Pellets 3/4 bags
8- Borehole diameter	8.25"
9- Grout	Type I Portland Cement

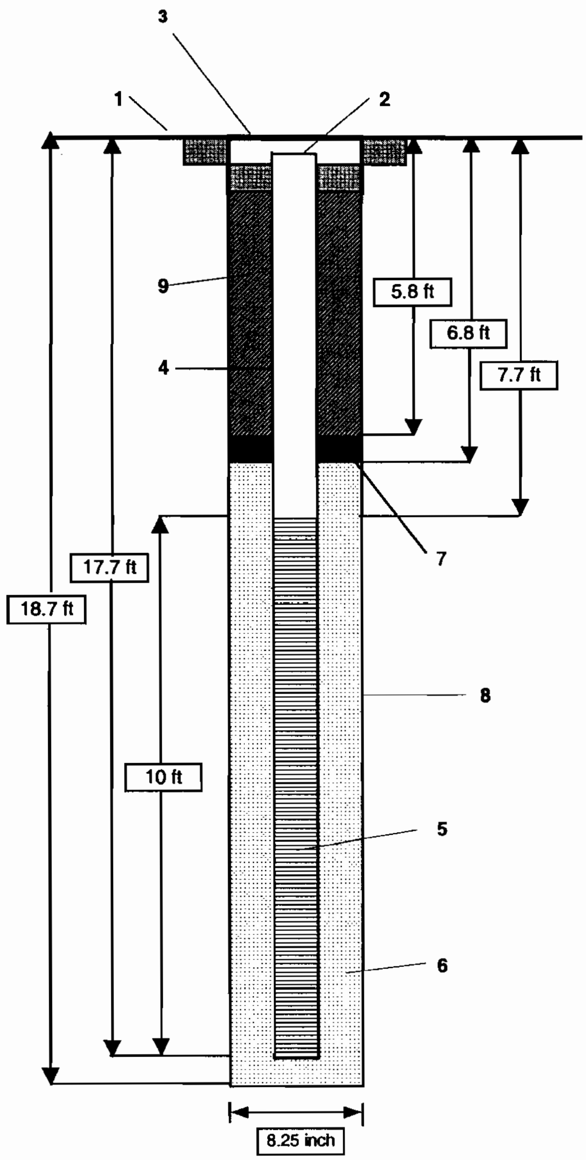
Note: Diagram not to scale.

PROJECT NUMBER	WELL NUMBER
158814.ZF	F617GW006 SHEET 1 OF 1

CH2MHILL

WELL COMPLETION DIAGRAM

PROJECT : AOC 617, Zone F, Charleston Naval Complex — LOCATION : Charleston, South Carolina
DRILLING CONTRACTOR : Prosonic Corporation License # 1435 — NORTHING 373398.02
DRILLING METHOD AND EQUIPMENT USED : Prosonic (8.25-inch diameter) — EASTING: 2319680.33
WATER LEVELS : not measured START : 10/30/2002 END: 10/30/2002 LOGGER : M. Karafa/ATL



1- Ground elevation at well	not measured
2- Top of casing elevation	10.15
3- Protective cover type	flush steel vault
a) concrete pad dimensions	48x48 inches
4- Dia./type of well casing	4-inch inside diameter schedule 40 PVC
5- Type/slot size of screen	0.010-inch dia. machine slotted PVC
6- Type filter pack	sandpack 7 bags
7- Type of seal	bentonite
8- Borehole diameter	8.25"
9- Grout	Type I Portland Cement

Note: Diagram not to scale.

PROJECT NUMBER	WELL NUMBER	
158814.ZF	F617GW008	SHEET 1 OF 1

CH2MHILL

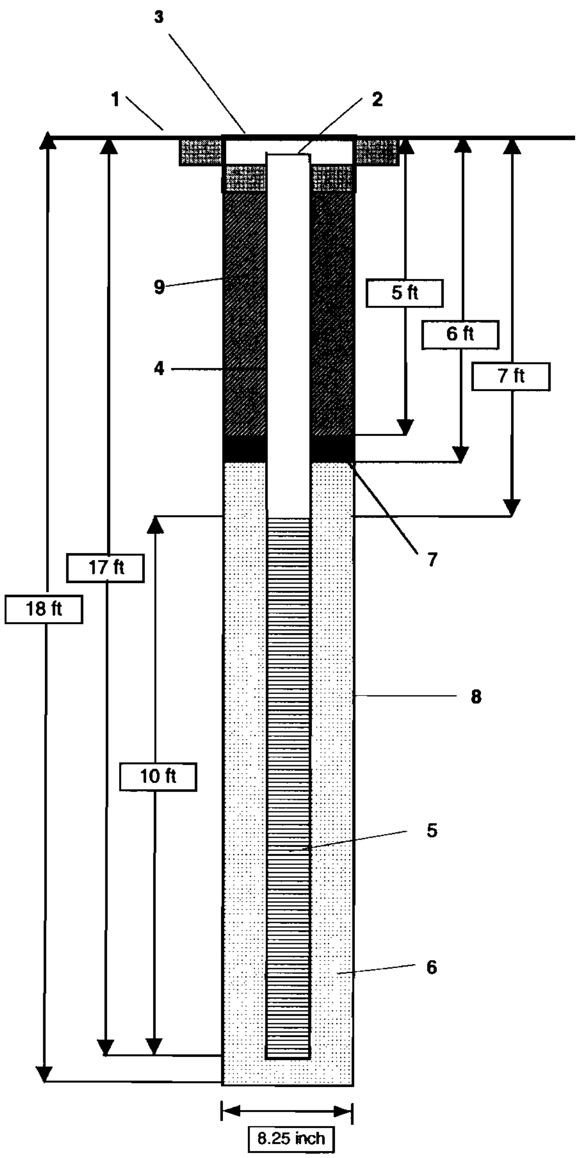
WELL COMPLETION DIAGRAM

PROJECT : AOC 617, Zone F, Charleston Naval Complex — LOCATION : Charleston, South Carolina

DRILLING CONTRACTOR : Prosonic Corporation License # 1435 — NORTHING 373362.13

DRILLING METHOD AND EQUIPMENT USED : Prosonic (8.25-inch diameter) — EASTING: 2319706.22

WATER LEVELS : not measured — START : 10/30/2002 — END: 10/30/2002 — LOGGER : M. Karafa/ATL



1- Ground elevation at well	not measured
2- Top of casing elevation	10.86
3- Protective cover type	flush steel vault
a) concrete pad dimensions	48x48 inches
4- Dia./type of well casing	4-inch inside diameter schedule 40 PVC
5- Type/slot size of screen	0.010-inch dia. machine slotted PVC
6- Type filter pack	sandpack 7.5 bags
7- Type of seal	3/4 - inch bentonite pellets, 1/2 bags
8- Borehole diameter	8.25"
9- Grout	Type I Portland Cement

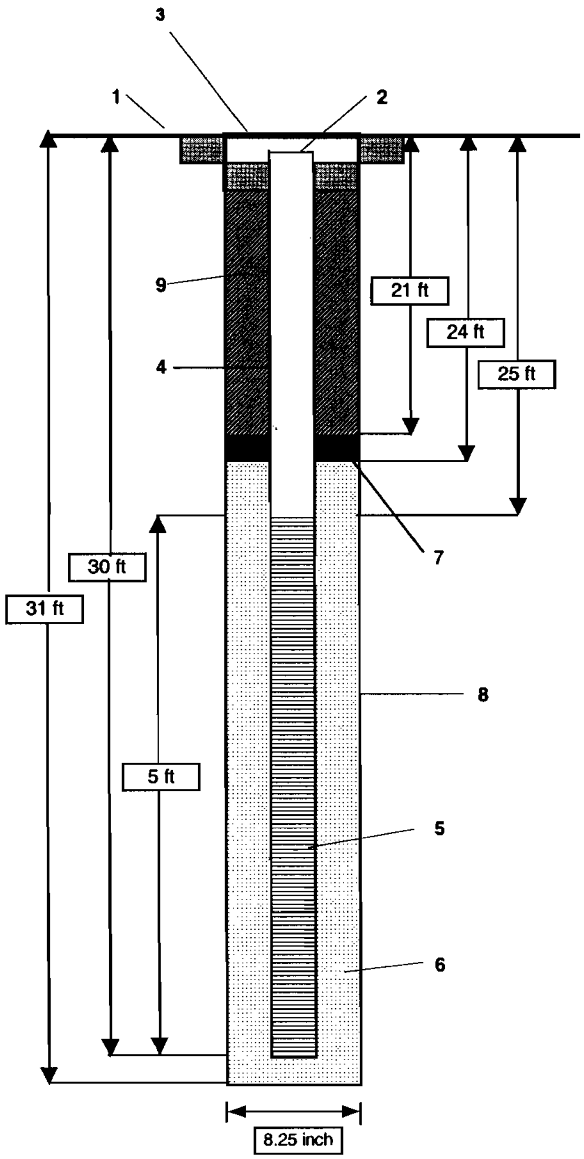
Note: Diagram not to scale.

CH2MHILL

PROJECT NUMBER	WELL NUMBER	
158814.ZF	F617GW07D	SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : AOC 617, Zone F, Charleston Naval Complex — LOCATION : Charleston, South Carolina
DRILLING CONTRACTOR : Prosonic Corporation License # 1435 — NORTHING 373368.86
DRILLING METHOD AND EQUIPMENT USED : Prosonic (8.25-inch diameter) — EASTING: 2319652.72
WATER LEVELS : not measured — START : 10/31/2002 — END: 10/31/2002 — LOGGER : M. Karafa/ATL



1- Ground elevation at well	not measured
2- Top of casing elevation	11.767
3- Protective cover type	flush steel vault
a) concrete pad dimensions	48x48 inches
4- Dia./type of well casing	4-inch inside diameter schedule 40 PVC
5- Type/slot size of screen	0.010-inch dia. machine slotted PVC
6- Type filter pack	sandpack 7 bags
7- Type of seal	3/4 - inch bentonite pellets, 2 bags
8- Borehole diameter	8.25"
9- Grout	Type I Portland Cement

Note: Diagram not to scale.